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Vol. 1 No. 9 (new series) SEPTEMBER, 1956

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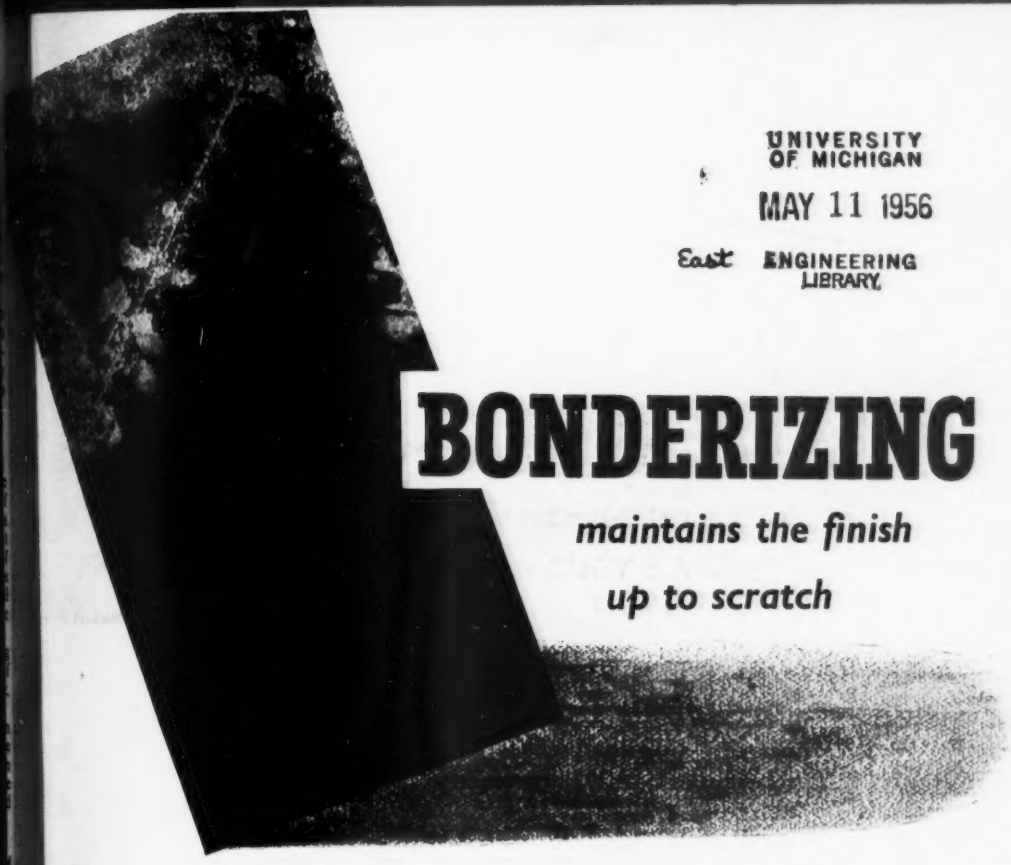

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING AND ALL METAL FINISHING PROCESSES.

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ADVANTAGE SERVER

IN this issue we include a supplement detailing the arrangements for the forthcoming International Enamelling Congress organized by the Institute of Vitreous Enamellers to which many overseas contributions have been forthcoming.

It is also a little more than a year now since the Fourth International Conference on Electrodeposition and Metal Finishing was held in London under the aegis of the Institute of Metal Finishing, while meetings of the Hot-Dip Galvanizers' Association, staged biennially since 1950, have also been on a comprehensively international scale.

Thus most of the major finishing technologies have shown themselves ready and willing to collaborate technically on an international scale in the interests of their respective industries, and to exchange across the barriers and boundaries of the nations their knowledge and experience.

It is not so many years since isolation and insularity were the avowed policies of many of the leading industrial organisations, and works practice and processes were secrets to be closely guarded against the possible machinations of potential spies from rival concerns. The futility of this attitude has now received almost universal recognition and the interchange of visits between the representatives of competing works and the presentation and discussion of papers describing works practice and research findings are now commonplace features of most technical meetings.

There are many aspects of this minor revolution in industrial policy which merit further thought and possible discussion. What perhaps emerges most clearly is the fact that management has recognized that in this present day and age it is virtually impossible to maintain workshop methods and processes completely secret for very long.

Much has been heard in recent months concerning the benefit or otherwise which can be deemed to accrue to a company marketing a metal finishing product, from refusing to divulge the formulation of the product, whether it be an enamel frit, a plating addition agent or a pickle inhibitor. It has been said with some justice that if a plating shop chemist is to be expected to maintain proper control over his solutions, he must know the constitution of all the mixtures which he adds thereto.

The contrary argument with which also some sympathy has been expressed, is that these formulations represent the fruits of much time and money expended on research, and to make them freely available to all and sundry would be to dispose of a valuable asset. Furthermore it can be claimed that only those who have done the research work necessary to evolve a certain formula are competent to adjust the formulation in the face of special circumstances, and that to permit workshop chemists to use their own initiative in this matter may well have undesirable consequences.

The final answer to these points is that any competent chemist can, in a few hours or days, determine the composition of virtually any product marketed, and therefore secrecy in itself has no real value. The commodity which the supplier of such a product is really called upon to make available, and which he can in his own way, ensure to be superior to that of his rivals, is service.

In other words, what is true of consumer goods is also, to a great extent, true of industrial processes. The fact that they are known by a specific name, which is widely publicized, means that they can be given the economic advantages of mass production, and that their sponsors are virtually compelled to ensure that a consistent minimum of quality and of service is always available and maintained.

It is encouraging to reflect that the present apparent readiness to open the doors of our works to visitors, both from this country and overseas, must stem, consciously or unconsciously, from an appreciation of this fact.

Talking Points by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

INDUSTRIAL ROUNDABOUT

AN interesting experiment has been initiated in the Manchester area, where 40 firms exchange regular monthly visits by small teams who examine each other's production methods with a view to finding improvements which could be applied to their own factories. Similar schemes are also being introduced into other regions under the auspices of the British Productivity Council. Although the firms exchanging visits are drawn from a wide range of industries, it has been found that many problems are of common interest, and useful contacts on a wide basis have been built up. Surprising results can be achieved, such as one instance where a firm was bringing in materials from hundreds of miles away which a local firm was discarding as waste.

It seems that such a scheme could, most probably, be operated in the metal finishing field, as there are considerable numbers of firms making non-competing products which nevertheless employ similar plating and painting on an extensive scale.

The more exchange of information and experience there is, the better it will be for the country as a whole. Only those who know everything there is to know about their subject can afford to be secretive today—and there must be very few claimants to such distinction around.

BARGAIN BASEMENT

READERS of this column will have observed that "Platelayer" has a liking for statistics. The balance sheets of technical societies offer considerable scope for statistical analysis, and I have recently been attempting to calculate what I have termed a "value coefficient" for a number of these bodies; this is defined as the ratio of the amount expended per member to the amount of his subscription.

Membership of most technical societies represents, as a rule, remarkably good value, and the "value coefficient" is seldom less than unity. The latest balance sheet of the American Electroplaters' Society with nearly 7,000 members shows that it spent over 180,000 dollars last year, or about 27 dollars per member, the annual subscription being 10 dollars. This gives a quite remarkable coefficient of 2.7.

The Institute of Metal Finishing does its members nearly as well. Last year it spent a little over £5,000 on its 1,200 or so members. This corresponds to over £4 per head, as against a subscription which at the time was only two guineas, giving a value coefficient of almost 2.

How it is done is another story!

QUID PRO QUO

RECENT developments in the printing industry are making it likely that in the near future electrodeposition as a means of making printing plates and rotogravure cylinders will meet with increasing competition from cheaper electronic methods of reproduction. It is, therefore, encouraging to find that, as a compensating factor, an entirely new field seems to be opening up for electroforming in printed circuits. As is by now well-known, these are produced from plastic sheets onto which thin films of copper are bonded; complex electrical circuits are made up by printing a pattern of the wiring diagram onto the copper in a chemically resistant ink, and then etching away the exposed copper in acid, leaving the circuit ready for the attachment of the necessary components.

These circuits are cheap and space-saving and are especially useful in the radio and electronic industries. It is, however, often desirable to increase the conductivity of the circuit as made in this way and this can be done by electrodepositing more copper onto it until the required thickness is reached. Also, to facilitate soldering operations tin or lead-tin alloys can be plated onto the copper, this being especially useful where the plates have to be stored for any length of time.

There is every likelihood that this development will open up an extensive new field of application for heavy deposits.

NEGATIVE TECHNOLOGY

A RECENT issue of the vivid Journal of the Institute of Directors included a contribution on " How to Grow a Fine Crop of Ulcers." The instructions were most explicit and detailed, although the average executive would probably already be fully conversant with the technique. Nevertheless an article in this vein is probably more effective than all the exhortation in the world.

If this style of writing catches on we may yet read papers on " Methods of Increasing Finishing Costs " or " The Production of Blistered Electroplating." Authors, forward please!

A Paper Presented to the Northern Section of the Institute of Vitreous Enamellers

The Assessment of Adhesion of Vitreous Enamels by Torsion

by **W. H. F. TICKLE, M.Sc., F.R.I.C.,* M. K. KNOWLES, M.Sc. (Tech.),* *and* H. CRYSTAL, M.Sc. (Tech.)***

Introduction

THE exact assessment of adhesion is a difficulty confronting many industries and is a stumbling block in research work on paint, electroplating, adhesives and vitreous enamelling.

It is possibly true to say that no test has yet been found which provides a reproducible numerical value for adhesion.

So far as vitreous enamelling is concerned, it is no doubt true to say that the development of enamelling technique has been thwarted in part by the absence of a reliable test for the assessment of adhesion which would give a reproducible and impersonal answer.

Up till 1948 the comparison of adhesion with few exceptions was purely a visual personal assessment but, after this date, determined attempts are in evidence which are directed at eliminating personal judgment.

History

It may be of interest to trace briefly the history of the scientific measurement of adhesion in the enamelling industry.

The first recorded attempts to measure adherence were made by E. Orton Jnr. in 1909(1). Two tests were used, *viz.* an impact test, the impact being made by a falling ball or a swinging hammer and, in the second, the test specimens were bent through a right angle. All these results were compared visually and, although other tests have been tried since, this impact test has now become the accepted commercial test and has been made the standard test in America.

Most of the theorists (2-10), including Kautz and King, used this test.

Although a ball is used in all cases, some workers prefer to let it fall on to the sample, whereas others press the ball into the sample or allow a weight to fall on to the ball, to produce a standard deformation.

The second method is obviously advantageous when different thicknesses of either steel sheet or enamel are being used.

C. J. Kinze and J. B. Miller(9) were the first to utilize the method of pressing the ball into the sample. Their apparatus was constructed from a press with a holder for the specimen and guides for the ball-bearing. After testing in this manner the samples were compared visually.

In order to give more exact values to adherence, rather than relying on visual observation and judgment, various methods of assessing the degree of damage after impact have been tried. Thus R. D. Landrum(3) in 1912 estimated the loss in weight after testing but the results were not reproducible.

Other methods of assessing the area after impact include the use by J. L. McLaughlin(12) of a multipurpose reflectometer (1949). Dietzel suggested a method developed in 1949 by L. Stuckert who assessed the reflectance of the specimen by means of a photometer after destructive testing.

The dropping ball or similar test, although still in everyday use, is not an accurate method of assessing adherence. In order to use it with any accuracy at all, the use of statistical analysis is undoubtedly needed. A test developed in 1951 by the Department of Scientific and Industrial Research(14) for the adherence of electrodeposited coatings to metals bears this out.

A hammer vibrated by an electromagnet is allowed to impinge on the sample. The test is used purely to ascertain whether adherence exists or not.

An early test used by W. N. Harrison and G. T. Thaler(15) in 1928 deserves more recognition than it appears to have received. It was not easily carried out but, at least, it succeeded in giving numerical values to the measured adherence. Two test specimens similarly treated were held a slight distance apart in a special holder whilst being fired. When the enamel had matured, the two specimens were pressed together with special

*Manchester College of Technology.

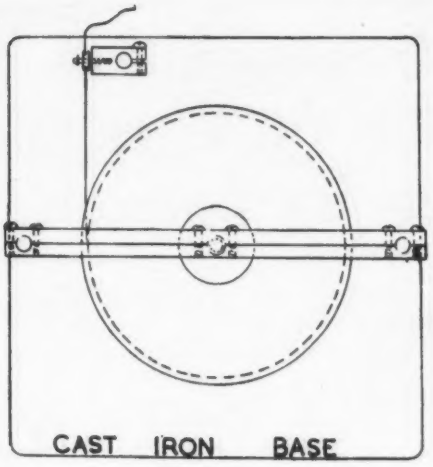
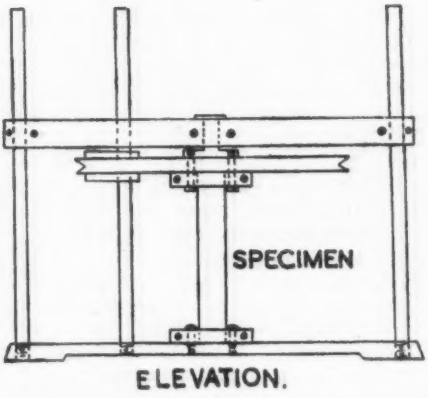


Fig. 1.—Torsion machine.



tongues, annealed at 500°C. and, after cooling, placed in a tensile testing machine. The results were expressed in terms of breaking strength. This test revealed the tremendous increase in strength due to nickel and cobalt flashing but with failure often occurring in the enamel and not in the bond. The method never became popular.

In 1925 R. R. Danielson and W. C. Lindemann [16] constructed a machine for measuring the cross-bending strength of enamels.

The specimens were deformed in an arc of a circle and when enamel first began to chip the deflection was measured. It is interesting to note that these workers differentiated between impact and bending tests. This difference had also been reported in 1937 by R. M. King, who showed that results from the two methods were not comparable.

In an attempt to assess adherence more accurately, J. E. Sains[17] in 1940 adopted tensile tests using firing time, enamel thickness and firing temperature as variables. He compared results with dropping ball tests and studied photomicrographs of the interfaces of similarly treated specimens. All the samples were stretched to the same degree and then compared visually. It is certainly a better test than the impact test, since it provides larger area for comparison but it cannot supply numerical values for the adhesion. Due to the metal strip being stretched beyond the elastic limit, mathematical treatment should be extremely difficult. An elongation of only eight per cent was necessary to remove all the enamel when firmly adhering, and the rate of stretching was found unimportant.

A torsion test was employed by P. L. Smith[18] in 1940 to measure resistance to chippage. This followed from research which showed that resistance to torsional stresses in enamelled ware was of prime importance. The samples were cylindrical and were twisted until the enamel shattered off the surface. Results were compared with impact-test data. Later the Porcelain Enamel Institute in 1946 used the torsion test again. The specimens were "L" shaped and, when the angle at which chippage commenced at the corner was plotted against the enamel thickness, a remarkably smooth curve was produced.

In 1948[11] details were published of a new adherence tester which proved to be nothing more than the impressed ball test of Kinzie and Miller but the assessment was carried out by electrical means. The apparatus consisted of a type of brush head, holding 169 needles, covering an area of one square inch. The area which remained covered with enamel was thus computed. This test was adopted by the American Society for Testing Materials as a tentative standard test.

Although it is preferable to visual observation, it still suffers from the inaccuracies of the ball test itself and, while the fineness of discrimination is limited to 169 points per square inch of contact, to put it one way it is still coarser than a fine Persian rug and, consequently, the eye itself is capable of better discrimination. The method, however, does provide an impersonal numerical answer.

This test was adopted as a tentative standard by the Porcelain Enamel Institute, Inc. and Bulletin T-17 evaluates adhesion as an index, *i.e.* the metal exposed by the test is expressed as a percentage of the total area of deformation.

The Apparatus Employed

The torsion unit constructed in this research is shown in Fig. 1; the final assembly is illustrated in Fig. 2.

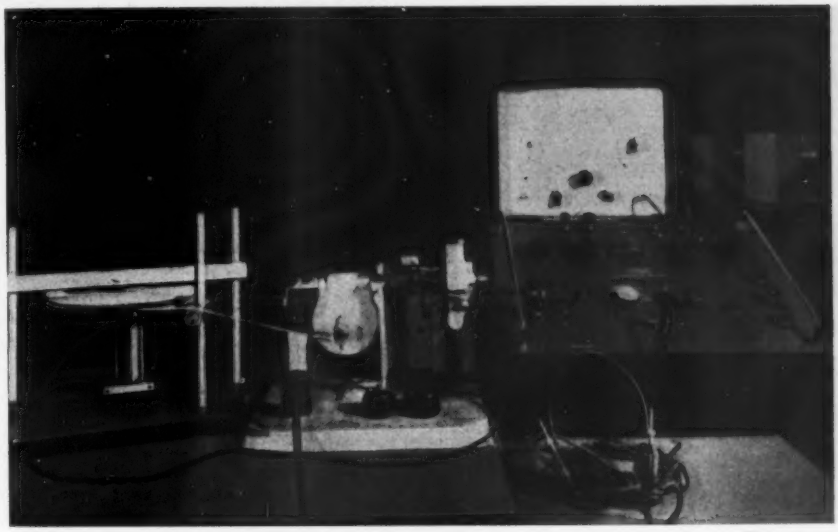


Fig. 2.— Photograph of the unit finally adopted.

In its original form, no method of independent assessment of failure was employed.

The specimens were held at either end by chucks, one of which was secured to the cast base plate at the bottom. The upper chuck was rotated by means of the large wooden pulley wheel, the upper surface of which carried a scale graduated in degrees as shown in Fig. 2.

The torque was applied by means of cord driven by a motorized windlass. The motor could run at two speeds, *viz.* 3,760 and 9,600 revolutions per minute. The reduction through the gears was approximately 69,000 and, as 6-inch specimens were used providing a 5-gauge length between the chucks, the rate of twist was either 0.011 or 0.028 revolutions per minute per inch of specimen.

The lower speed was used through the tests as, according to standard torsion-test data, the rate of twist should not exceed 0.01 revolutions per minute per inch of specimen.

The instrument as constructed can accommodate specimens up to 10 inches in length.

Experimental Method

The elastic limit of the steel was determined first by twisting plain strips of 20 B.G. enamelling grade steel and measuring the strains produced by known values of torque.

To measure the latter quantity, a spring balance was used to assess the tension in the string, the strain was read directly from the scale on the pulley wheel. The results were plotted directly as tension in the string, against angle of twist, as the factors necessary for conversion to torque and strain are all constants, also the angle of twist at which the elastic limit is reached is the value of most interest.

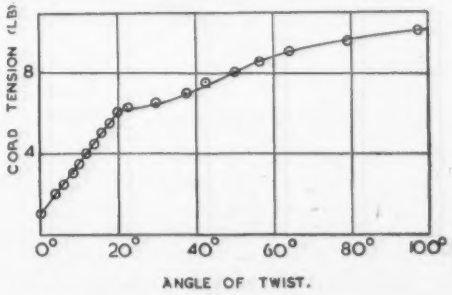
Such a graph is shown in Fig. 3, from which it can be seen that the steel is elastic up to an angle of 22-23 degrees. Twisting beyond this produces permanent deformation.

The "angle of yield" was always reproducible but, beyond this angle, the results were not reproducible, which introduces a major complicating factor as it has been considered a possibility that the angle at which chipping of an applied enamel commenced might have offered a measure of its adherence.

However, a definite decision can be made between poor and good adhesion—when adhesion is poor the enamel shatters off in large flakes at a relatively low angle of torque, whereas if adhesion is good the enamel will fail at a high torque and explode off the steel in the form of powder.

In these latter cases, it would appear that failure is wholly in the enamel layer—and not at the bond. Moreover, the enamel that remained attached to the steel was always black in colour,

Fig. 3.—Torsional stress - strain relationship of typical enamelling steel. Torque - (4.22 × ordinate) lb. in.



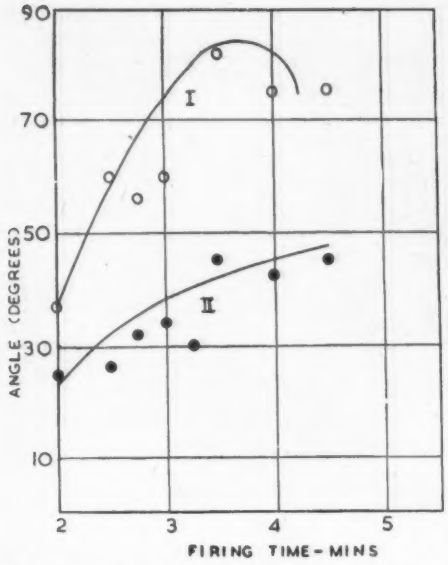


Fig. 4.—I. Graph of the angle of failure against firing time. II. Graph of the angle at which the first chip occurred, against firing time.

whereas in cases of poor adhesion the large flakes carried with them an iron oxide layer and left a bright metal surface.

We have subsequently shown in a fresh piece of investigation the nature of this oxidation and the critical limits necessary to produce adhesion.

When adherence was good, cracks appeared in the enamel at roughly 45 deg. to the vertical, starting at the edges and eventually extending the whole way across as the angle of twist was increased. Photographs of these cracks have been shown by Peterson, Jones and Allen in 1948.

Later experiments, in which the strips were twisted still further so that the dark layer of particles left on the steel after failure also shattered off, showed that the steel surface was grey and matt which indicated that an erosive type of effect had occurred. Such a surface was never obtained when groundcoat GSI/GS2 was used, unless the steel was nickel flashed prior to enamelling.

Although the results shown in Fig. 4 were encouraging, it was decided to attempt an electrical method of assessment. Accordingly, the circuit shown in Fig. 5 was employed.

The main feature of the apparatus is the glass cell which is free to rotate with the specimen, the electrolyte employed being 1 per cent HCI.

The method of operation may be set down seriatim:—

1. Adjust current to 500 micro-amp.

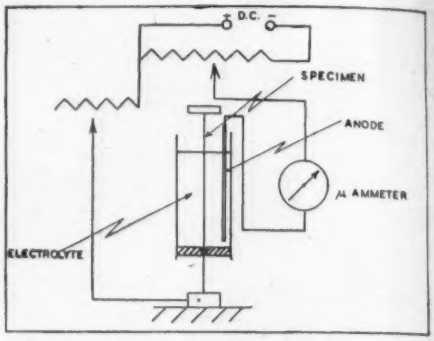


Fig. 5.—The original circuit employed.

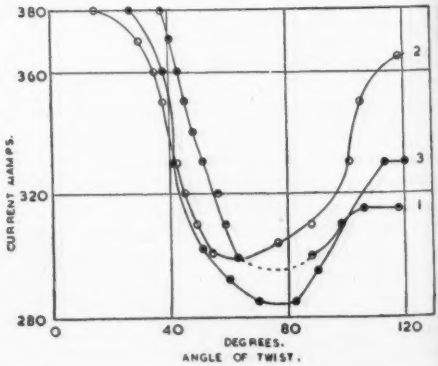
2. Current falls due to polarisation to about 380 micro-amperes after 15 minutes.
3. When 30 deg. is reached, the current decreases rapidly.

A point is then reached where the current stays steady for a short time and then it begins to increase again, this increase being accompanied by enamel failure and splintering. An increase in current due to enamel shattering was all that was expected—but it is evident that a back or opposing e.m.f. was being developed. The graph shows this in Fig. 6.

Objections to this Apparatus

1. The distance apart of the electrodes is continually being altered.
2. The electrolyte has an effect on the enamel.
3. Application of shear forces to the specimen of steel regardless of coating may produce a change in potential.

Fig. 6.—The variation of current with angle of twist. (Furnace temperature 850°C. Enamel G.S.1/G.S.2.)
(1) Firing time 3½ minutes - adhesion good.
(2) Firing time 3 minutes - adhesion very good.
(3) Firing time 5½ minutes - adhesion very good.



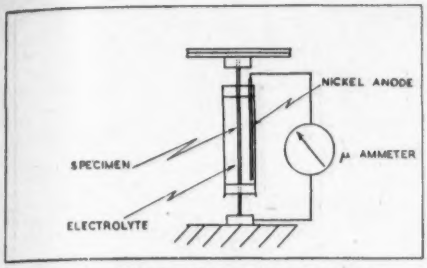


Fig. 7.—The simplified cell arrangement.

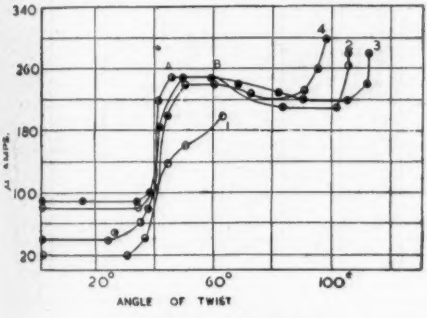


Fig. 9.—Variations of current with angle of twist. Enamel G.S.1./G.S.2.
(Firing temp. 850°C.).
(1) Firing time 6 minutes - adhesion very good but overfired.
(2) Firing time 4½ minutes - adhesion very good.
(3) Firing time 8 minutes - adhesion very good but overfired.
(4) Firing time 4 minutes - adhesion very good.

Simplified Apparatus

The apparatus was simplified. A nickel anode was employed with 1 per cent sodium chloride as an electrolyte without an applied P.D. as illustrated in Fig. 7.

When first introduced, a current of about 200 micro-amp. quickly fell, due to polarisation, after which the torque was applied.

The effect may be explained seriatim, by reference to Figs. 8 and 9.

1. Current remained steady until 30 deg. was reached, after which it began to increase rapidly.
2. When adhesion was poor, large flakes of enamel left the specimen and the current increased.
3. The steady portion AB indicates that the cracks are opening at the same rate as polarisation is occurring (Fig. 8).
4. At point D the bulk of the enamel began to fail and exploded from the steel as a powder, causing a rapid increase in current (Fig. 8).
5. Specimens which were overfired did not show a maximum but a point of inflexion.

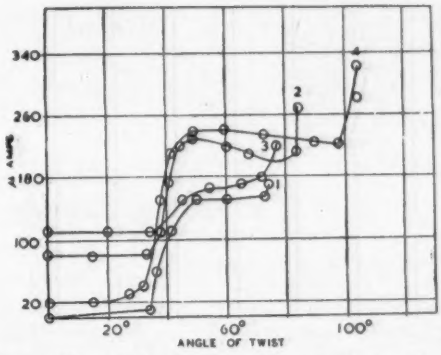


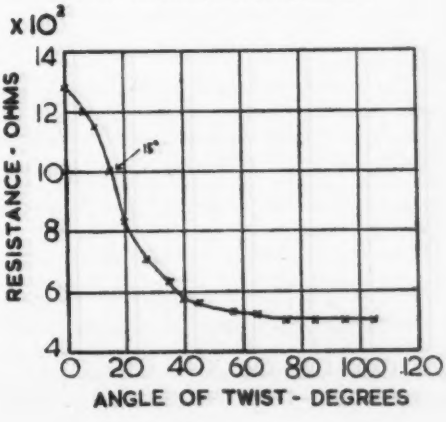
Fig. 8.—The variation of current with angle of twist. Enamel G.S.1/G.S.2.
(Firing temp. 850°C.).
(1) Firing time 2 minutes - adhesion nil.
(2) Firing time 2½ minutes - adhesion fair.
(3) Firing time 3 minutes - adhesion good.
(4) Firing time 3½ minutes - adhesion very good.

Microscopical examination of the specimen during torsion showed that the sudden and rapid decrease in current was associated with the formation of very fine dark hair lines in the enamel. It is probable that the cracks go right through the enamel to the metal, causing an increase in the area of exposed electrode and, consequently, an increase in the cell potential.

Since the latter was found to be in opposition to the applied potential, the result was a decrease in the circuit potential and, consequently a fall in the measured current. When the current remains steady, the enamel is assumed to be "saturated" with these cracks.

The value of the angle at which this steadiness in current is generally achieved is always found to be about 60 deg., indicating that, when adhesion was present, the enamel composition was the

Fig. 10.—An example of poor adhesion.



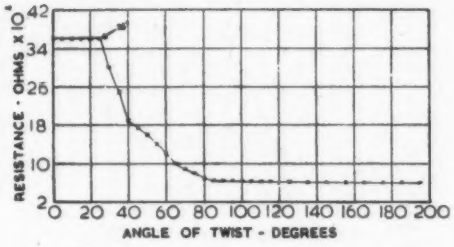


Fig. 11.—*An example of fair adhesion.*

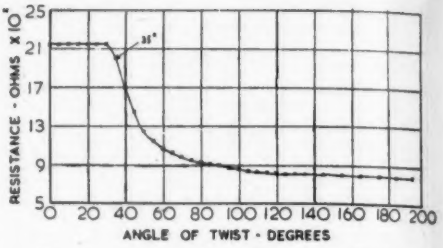


Fig. 12.—*An example of satisfactory adhesion.*

factor governing the formation of these cracks.

When the greater bulk of the enamel had flown off, the current had decreased, owing to diminution in circuit resistance. After complete removal of the enamel, the current remained steady.

These peculiar arrests in the graphs are, no doubt, in part explained by the complicating factor of the e.m.f. developed when a plain steel specimen is itself subjected to torsion in contact with an electrolyte, forming one electrode of a cell.

Specimens that had been overfired did not show a maximum minimum but a point of inflexion as shown in graph 3, Fig. 9.

It does appear that some trend exists towards a point of inflexion which is indicative of good adhesion.

In order to avoid polarisation effects, an A.C. current was applied by means of a signal generator and a simple A.C. bridge circuit was employed, a null point being obtained on telephones as the torsion proceeded by arresting the operation and obtaining an end point at each angular reading.

It was found that ordinary distilled water was quite suitable for use in the cell and offered obvious advantages over the use of an electrolyte.

Further, the nickel strip was now replaced by a cylindrical piece of copper gauze which offered the advantage of assisting in maintaining a fixed capacitance during torsion and, secondly, the advantage of allowing the specimen to be viewed throughout the test.

Figures 10 and 11 show the difference which may be expected between good and bad adherence. The pronounced fall in the case of poor adherence shown in Fig. 10 is unmistakable.

A self-balancing recorder would be a useful improvement which could be incorporated for routine testing.

In order to facilitate the comparison of specimens, and, in view of the fact that each specimen as prepared and inserted in the cell has in practically every case a different specific resistance, it was decided to adjust the value of the resistance ordinate to obtain coincidence of resistance reading when replotting the results; the abscissae are, of course, unaltered as shown in Fig. 12.

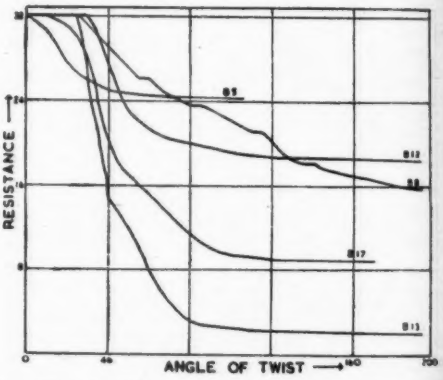
Enlargement of the scale of plotting throws results further into relief, as shown in Fig. 13.

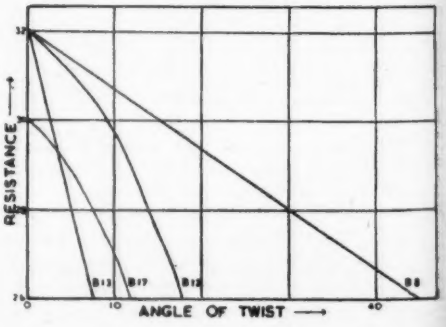
Conclusions

The main advantages claimed for this instrument are:—

1. It gives an impersonal assessment of adhesion under torsion.
2. It is simple to use and the angle of failure is reproducible.
3. By replotting the results, as explained in

(*Continued in page* 387)





Figs. 13 *and* 14.—*Illustrating the graphical technique employed in presenting comparative results.*

TEMPERATURE CONTROL SYSTEMS for Electroplating Vats

by D. W. TAYLOR, Grad. I.E.E.*

FOR many processes in electro-plating, optimum results can only be achieved when the temperature of the bath lies between critical limits. This necessitates some form of temperature control which can become quite complicated if the critical range is small or if the volume of liquid to be controlled is large.

With small installations such as the hand plating line with a heating medium of gas, or electricity, or steam/hot water, control of the bath temperatures may be affected by the operators taking thermometer readings and regulating the supply of heat accordingly. This is perhaps the simplest form of temperature control, but owing to the necessary intervention of a human operator, its applications are obviously limited to small vats where fine control is not necessary.

With the growth of large fully automatic plating installations has come the need for automatic control of large volumes of liquid to fine limits, and it is here that automatic closed-loop systems of varying degrees of complexity have come to be applied.

Temperature control is a term embodying any type of regulation of a source of heat, either by direct control of the heating medium or by control of the fuel which is necessary to produce this heating medium.

All such controlling apparatus must have as an integral part some type of temperature-sensitive element, *i.e.* a thermostat, and a controller, which acting on signals given it by the thermostat governs the input of heat to the controlled bath. Various types of thermostats can be coupled to numerous different types of controller and for simplicity, these circuit elements will be considered separately.

Thermostats

Thermostats may be divided into four main groups, according to their form of sensitive element, *viz.*, Liquid, Vapour, Bi-metallic and Resistance.

The Liquid Type of thermostat depends upon the principle of expansion and contraction of the liquid contained in a bulb (usually alcohol or mercury) to operate a control system.

The Vapour Type of thermostat consists of a bulb which is partially filled with a volatile liquid which vapourizes when the temperature rises. The increase in pressure acts on a spring, under the Bourdon-tube principle, and the torsional deflection of this spring element is used to operate the control system.

The Bi-metallic Type of thermostat employs the deviation from its normal position of a bi-metal strip with temperature changes, to operate control. The usual method is to fit contacts in the head of the thermostat which are opened and closed by the movement of the bi-metal, these contacts being used to make or break an electrical circuit.

A special type of bi-metal thermostat is the Invar rod and tube type which depends upon the expansion and contraction of a metallic tube which surrounds an Invar rod. This rod is fixed to one end of the tube, and due to the different coefficient of expansion of the rod and tube, the free end of the rod moves relative to the surrounding tube and thus actuates some control system. The coefficient of expansion of Invar is so low that its length does not appreciably alter with temperature changes.

The Resistance Element Type of thermostat consists in its simplest form of a Wheatstone Bridge. One arm of the bridge, a wire element of known resistance, is immersed, in a bulb, in the bath to be controlled. The circuit of the bridge is balanced at the required temperature, consequently any deviation from this temperature, which in turn alters the resistance of the immersed element, upsets the balance. The out-of-balance is used to operate high/low relays to complete the circuit to a controller, usually a motorized valve of the modulating type.

Control Systems

Both the Invar rod and tube thermostat, and the liquid type, are commonly used with a simple direct linkage to a diaphragm valve which controls the heating medium. This type of control system

*Electro-Chemical Engineering Co. Ltd.

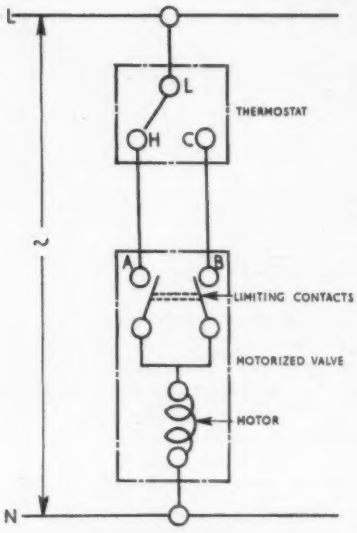


Fig. 1—Diagram of circuit of electrical controller fitted with thermostat and high/low temperature contacts.

is ideal for easily controlled media and solutions where fine control is not required. Apart from these types of mechanisms there are three main groups, *viz.*, Electrical, Pneumatic and Hydraulic circuits, which upon receiving signals from one of the group of thermostats, dealt with above, operate the valve controlling the heat input.

Electrical. There are two widely used methods under this heading which employ a thermostat fitted with high/low temperature contacts or the resistance element type through which an electrical circuit can be made or broken. (*a*) This circuit can be linked to a simple motorized valve. This unit consists of a motor which is mechanically linked to an ordinary piston valve. Upon rotating 180 degrees, the motor causes the valve to open and a further 180-deg. movement causes the valve to close. The unit is fitted with two limiting contacts, one opening and one closing at the end of the first 180-deg. movement and the reverse at the end of the second 180-deg. movement. This ensures that the circuit to the motor is broken at the end of the valve movements. (*See* Fig. 1.)

When the thermostat is in the position shown, *i.e.* temperature too high, a circuit is made to terminal " A " on the motorized valve. The limiting contact in series with " A " is closed when the valve is open and allowing the heating medium to flow. Thus a circuit to the motor is completed and the valve is shut. When the valve closes the limiting contacts reverse thus breaking the circuit to the motor. The valve will remain closed until the temperature drops below the preset limit when the thermostat switch changes over to contact " C." A circuit will thus be made *via* the limiting contact " B," this will cause the motor to rotate a further 180 deg. and open the valve.

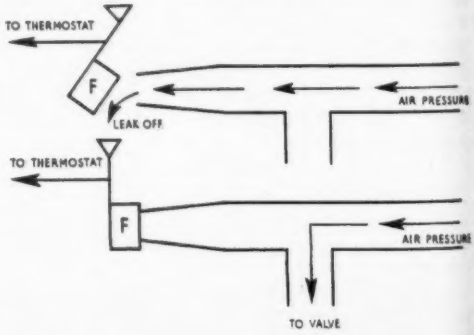
(*b*) This circuit can be connected to a modulating valve *via* a regulator which emits timed pulses.

The valve itself is controlled by direct linkage with a reversing motor, which is fitted with limiting contacts for valve positions " fully open " or " fully closed." The regulator completes a circuit to the thermostat for a preset time at given intervals, say 5 seconds every 60 seconds. When the thermostat switch is not in the neutral or " off " position but closing either the " high " or " low " contacts, a circuit is completed to the motor for this preset time. Thus the motor rotates and starts to close or open the valve. At the end of this preset time the circuit is broken regardless of whether or not the valve is in the " fully open " or " fully closed " position. After the given interval has elapsed a circuit is again made to the thermostat and once again, if the contacts are either in the " high " or " low " positions, a circuit is made to the motor.

This sytem is usually adopted where the solutions being heated are not easily controlled and the timed interval of operation allows the new setting of the valve to take effect throughout the vat instead of in areas local to the source of heat. Using system (*a*) under such conditions would bring about " hunting " of the valve due to the fact that the valve is either open or closed and thus the full supply of heat or none at all is passing to the vat.

Pneumatic. This group of controllers use a thermostat to operate various types of pneumatic systems which in turn operate the valve governing the source of heat. Once again this can be a simple open/closed mechanism or one of the gradual throttling type.

Fig. 2.—Diagrammatic illustration of principle of operation of pneumatic temperature controller.



The basic principle of one such mechanism is illustrated in Fig. 2.

The movement of the pilot valve " F " is controlled by the thermostat which can make it open/closed or throttling according to the system in use. This valve is connected to the air circuit and when open allows air to leak away. The thermostat now throttles or closes this valve and accordingly some or all of the air pressure is directed to the diaphragm valve controlling the source of heat. This type of system can be extended to incorporate gas-heated tanks, although such a heating medium is only used on very small installations.

Fig. 3 shows the basic principles of such a system. The gas enters the diaphragm valve and passes under the diaphragm and out to the burners. Some small percentage of the gas passes through to the top side of the diaphragm and is piped to the thermostat. In the head of the thermostat is the pilot valve "F" operated by the thermostat. The other side of this pilot valve is piped to the flame. If the valve "F" is open there is a free passage of this auxiliary gas supply to the flame and the pressures on the top and bottom of the diaphragm in the main valve are equal, this allows a free passage of the main gas supply to the burners. When the temperature in the vat rises the pilot valve " F " is throttled and a back pressure builds up on top of the diaphragm in the main valve. This depresses the diaphragm and the main gas supply is throttled until pressure above and below the diaphragm is again equalized.

Hydraulic. Controllers in this group can be either water or oil operated. A basic system using water is very similar to that shown in Fig. 2 for air but with the addition of a drain for the " leak-off " water.

Fig. 4 shows the basic principles of a widely used oil system. A pivoted jet, whose movements are controlled by the thermostat, directs oil into one of the channels leading into the cylinder. The

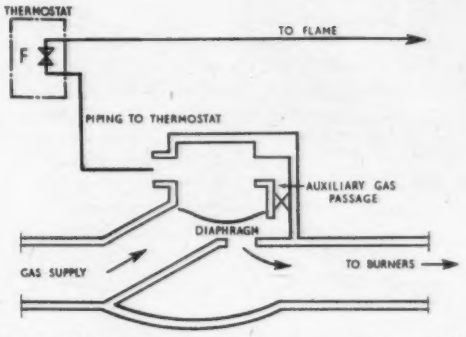


Fig. 3.—Principle of operation of a temperature control for a gas-heated tank.

oil pressure in the cylinder moves the piston which in turn is linked to the valve controlling the heat input. Any intermediate position of the jet directs oil into both channels in a relationship which is proportional to the actual position of the jet and the piston is stabilised accordingly, giving a throttling action to the valve.

Apart from the above-mentioned control systems for regulation of heating media, the thermo-sensitive element can be used for operating other pieces of ancillary equipment which cannot be noted under the heading of controllers.

On large automatic plant it is sometimes desirable to have a remote indication of bath temperatures, at some centralized control panel. This can be accomplished by dial thermometers actuated by thermo-sensitive elements in the bath. Again, the elements of numerous baths may be connected by way of individual switches to a multi-station indicator. This instrument has one indicating dial, but by merely closing the appropriate switch it will show the temperature of the selected vat.

The thermostat can also be used to operate visual or audible warning devices, to draw attention to the deviation from mean temperature

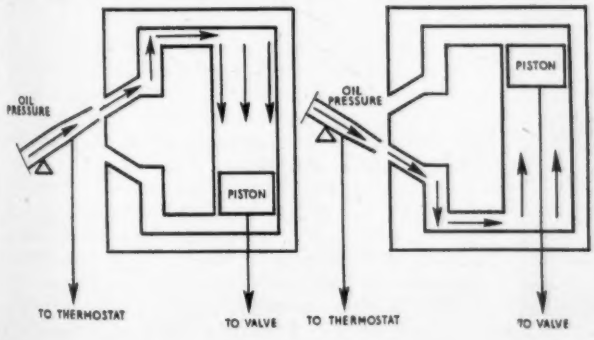


Fig. 4.—Diagram of method of operation of oil-operated hydraulic-type temperature controller.

in any particular vat.

The impulses from thermostats can be used to actuate the pen movements of chart recorders, so that a continuous record of vat temperatures may be obtained for laboratory records. (Fig. 5).

Under ideal conditions, most of the solution in a vat will be at the desired temperature, with the exception of the solution immediately adjacent to the source of heat. The thermostat would thus be located anywhere in the vat where it would cause no obstruction except at the point of heat source. These conditions are not found in practice, although by solution circulation an approximation may be reached. As in practice there will be turbulence caused by the work entering and leaving the vat, and movement of solution by convection, there will not be a point of " average temperature " where the thermostat may be located. However, by positioning the thermostat at what would be an undesirable point under ideal conditions (*i.e.* near the heat source) very much closer average temperature control is possible.

On some large vats it is desirous from an economic standpoint to use a type of heat exchanger embodied in the actual vat. This takes the form of one or more batteries of heating coils contained in blisters around the tank. The partition between the blister and the actual vat is designed so as to allow a continuous thermo-

Fig. 5.—Instrument panel installed in laboratory for remote supervision of plating plant.

The top right hand corner of this panel contains high/low temperature indicating lamps.

The bottom right hand corner of the panel contains a thirty-two station selective temperature indicator.

The bottom of the other three sections contains temperature chart recorders.

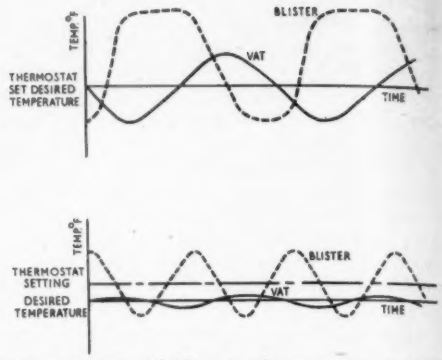


Fig. 6.—Variation of efficiency of temperature control with different location of thermostat.

a. (above) Thermostat in vat.

b. (below) Thermostat in blister.

syphonic action to take place.

If the thermostat is located at the point of " average temperature " and set at the desired temperature of the bath, when this temperature is reached and the heat supply is cut off, the temperature in the blister will be considerably greater. This is due to the time taken for the heat to circulate through the greater bulk of liquid in the bath, (*See* Fig. 6a). Again when the temperature at the thermostat has dropped sufficiently for the heat supply to be switched on the temperature of the blister will be considerably less. Thus the temperature of the bath as a whole will remain above or below the critical temperature for long periods due to this time lag.

Now, if the thermostat is positioned in the heating blister and set for some temperature above that desired (this higher temperature being found empirically under operating conditions of the particular vat, the temperature of the blister will remain reasonably constant, because the blister may be considered as a small tank with a large heat input. Thus the flow of heat from the blister into the bath will also remain constant keeping the bath temperature close to its desired point (*See* Fig. 6b).

These principles of temperature control may in some cases be combined with an artificial cooling system (*e.g.* refrigeration) where the effects of secondary heat inputs are greater than the effects of normal heat losses, on a vat. As an example, a small tank processing work subject to high current densities, represents a case where there is a constant high level heat input (due for example to I^2R losses) which cannot be controlled by a thermostat. In such a case, the heat output (*i.e.* losses) must be thermostatically controlled and the same principles as above are applied, but in the opposite sense. (*continued in page* 387)

The Assessment of Adhesion of Vitreous Enamels by Torsion

(*Continued from page* 382)

the text, a rapid comparison of adhesion is possible.

4. A more sensitive indication of variance of adhesion is provided by the instrument which is useful for research purposes.
5. If desired, the area under the curve may be computed by means of a planimeter to afford a measure of adherence.
6. The instrument is not designed to displace an impact test, neither is it inferred that the results obtained by torsion are directly comparable with impact test results.
7. It is recommended that the instrument is used in conjunction with an impact test.
8. The true function of the instrument is to provide a more complete picture of adhesion than is available at the moment from impact tests alone.

Acknowledgements

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Refrigeration Services Ltd., Ashton-under-Lyne.
Widnes Foundry and Engineering Co. Ltd., Widnes.

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PRODUCTION ENGINEERS' COMMITTEE PUBLISH FIRST REPORT ON WASTAGE

Further Work Scheduled on Paint and Enamel Usage

A REPORT published by the Institution of Production Engineers states that valuable materials are being wasted every day in most factories in the British metal-working industry. The report, which was prepared by a section of the institution's Research Committee, shows the extent to which metal-working firms are making the best use of their materials, and what proportion is converted into useful products.

"For a wide range of machined parts (the report states) the proportion of material purchased which is converted into saleable goods is seldom greater than 70 per cent and is frequently less than 30 per cent. This is a challenging situation. Consider a not unusual material utilisation figure of 33 per cent of the original material, two-thirds is machined away and disposed of as swarf at about 10 per cent of its original cost. An increase in material economy, in this case to 70 per cent—which need by no means be impossible—would be equivalent to halving the material cost for this part . . . . The sub-committee is confident that there are few factories where it is not possible to make worth-while material savings by a vigorous attack on the problem."

Eventually the sub-committee hopes to investigate the use of materials in other industries, and the use of paints, enamels, and other finishes.

Temperature Control

(*continued from page* 386)

In some cases, such as long narrow vats, or vats of very large capacity, it may even be necessary to have several control systems, working separately from one another, but each controlling one section of the vat.

It will be seen therefore that the selection of a system to control the temperature of a given vat will depend upon the constants of the vat in question, together with such considerations as the volume of solution, and allowable differential from the desired temperature.

Acknowledgement is due to the Electro-Chemical Engineering Co. Ltd., for permission to publish this article and for loan of photograph.

Continuous Flow-Coating Paint Line in operation at DOUGLAS AIRCRAFT CO.

described by GORDON ASHMEAD*

THE longest continuously-moving paint line of its kind, capable of flow coating 6,400 Navy jet plane parts an hour, is in operation at Douglas Aircraft Company, Torrance, Calif., U.S.A.

It is an electrically-driven overhead monorail system nearly half a mile long. It can be operated at speeds of 10 to 30 feet a minute.

The conveyor dips into five different production locations to receive, without pausing, loadings of newly formed sheet metal airplane parts.

At one point, the conveyor plunges underground into a 378-foot tunnel which is divided into chambers. Here the parts move through a dozen different automatic phases—involving washing, rinsing, drying, and chemical processing.

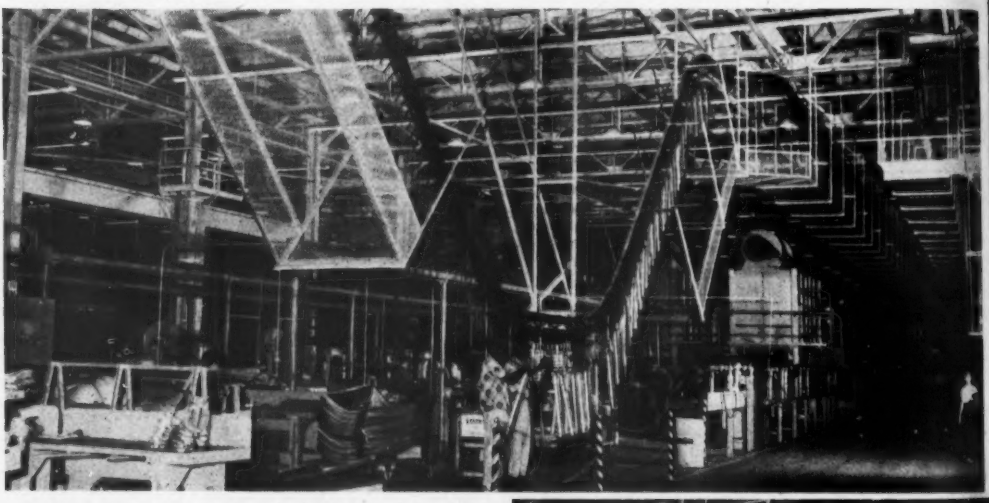
The advanced-type painting system can accommodate parts ranging in size from one inch to six feet square. The parts are hung on squeeze-type loops suspended from hooks fixed at four-inch intervals along the roller chain of the 2,100-ft. steel monorail.

The system employs the principle of flow coating, whereby paint is slushed on parts with a fan-like action from banks of nozzles on the sides and bottom of the processing chamber.

The flow-coater utilizes 30 to 40 gallons of zinc chromate primer during two eight-hour work shifts each day.

If a fire should break out, all finishing operations will be automatically halted by an electronic safety device and carbon dioxide will be discharged into sumps and all closed drains.

Parts are hooked on the conveyor at the five loading stations by Douglas employees, and the monorail curves sharply upward as it leaves each loading station so as to conserve work space on the shop's floor. Safety screens protect personnel



1. (*Above*)—*Workers load parts on the conveyor at the beginning of the new flow-coating line.*

2. (*Right*)—*General view of the new Douglas paint line, showing how parts are conveyed up and down to conserve floor space.*

* Douglas Aircraft Co.

3. (*Above, left*)—*Close-up view showing how squeeze-type hooks hold parts on the conveyor.*

4. (*Above, right*)—*Parts are conveyed into the initial cleaning chamber.*

5. (*Above*)—*Unloaded hooks on the paint-line conveyor enter a dip tank, where paint on their surfaces will be removed before they are re-used.*

6. (*Right*)—*Parts enter underground processing and coating chambers.*

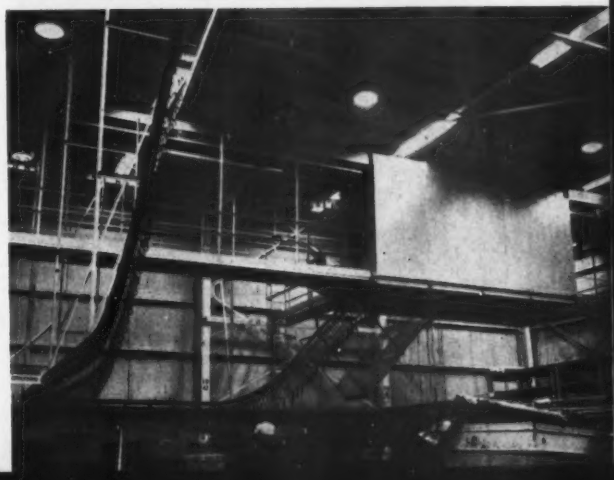
working below the conveyor in areas between loading stations.

Operations automatically accomplished with the new finishing system are as follows:—

(1) Alkaline spray cleaning.
(2) Hot water rinsing.
(3) Cold water rinsing.
(4) Alodine processing.
(5) Cold water rinsing.
(6) Hot chromic acid processing.
(7) Drying (in a 60-foot oven with blowers which deliver 450,000 BTU from steam at 100 lb. per sq. in. at 17,000 ft. per min.)
(8) Cold air blasting.
(9) Flow coating.
(10) Drying (in a low-temperature oven at 190° F.).

Following the last operation, the line dips to a central unloading area where parts are inspected and distributed to assembly or to stock along with work orders. Then the line rises to an overhead stripping chamber where all hooks are cleaned before they can be reloaded.

The new paint system is being used to process parts for the F4D Skyray jet interceptor, and other combat craft now being manufactured by Douglas for the U.S. Navy.



7. (*Right*)—*After leaving the drying oven, at right, parts are conveyed to a floor-level unloading and inspection station.*

METAL FINISHING IN ENGINEERING

New Finishing Developments on show at

THE ENGINEERING AND MARINE EXHIBITION

Olympia, September 1-15, 1955

A VISIT to the Engineering and Marine Exhibition, which has just ended its two-weeks show at Olympia, is always an interesting and worthwhile occasion, even to one whose interests are principally associated with metal finishing.

Apart from the small number of stands directly concerned with metal-finishing processes, there is a number of other exhibits of products and processes which relate to finishing subjects, and indeed to the far-sighted industrialist many of the purely engineering exhibits can be indicative of possible trends and developments in the finishing industry.

In the pages which follow those exhibits which may be considered to bear on one or other aspect of finishing are reviewed.

Among those exhibitors wholly or principally engaged in serving the metal-finishing industry was **Silvercrown Ltd.,** whose exhibits included two sizes of filter manufactured by the company and the patent multi-cascade rumbling barrel, as well as totally immersed barrels and the well-known centrifugal drier. Samples of Nickelex, the Silvercrown patent white-bronze undercoating for chromium were on show in both dull and bright finish.

On the stand of **The Walterisation Co. Ltd.,** were shown industrial products for which the Walterisation processes have been adopted as corrosion protection treatments.

Among these is the new Walterisation M.C. Process, a rapid massive phosphating treatment, specially designed to suit the large-scale production techniques of industry. Walterisation M.C. is particularly suited to automatic plants of all types, and provides a heavy phosphate coating with immersion times of only 10 minutes.

Also being shown was Fasbond, a paint-bonding process which operates with remarkably low temperatures and processing times. A new development of this, Fasbond L.W., which gives fine paint-bonding phosphate coatings with controlled coating weights is also on show. These processes are suitable for spraying by the new Walterisation Spray Phosphating Technique.

Development of the Walterisation Processes has been extended into the field of dry lubrication for wire and sheet drawing, stamping and pressing, as well as for bearings and wear resistance of moving parts.

Among other processes are Foscote, Deran, the Walterisation L. treatment for aluminium, and Walterblak; appropriate ancillary products are also available.

Fig. 1 shows one of the company's automatic tipping basket plants, suitable for use with processes for the large-scale rustproofing of small parts.

The fact that the Exhibition also incorporated the Foundry Exhibition meant that it included a number of exhibits featuring shot-blast processes, a particularly impressive stand being that of **Tilghman's Ltd.,** jointly with their representatives

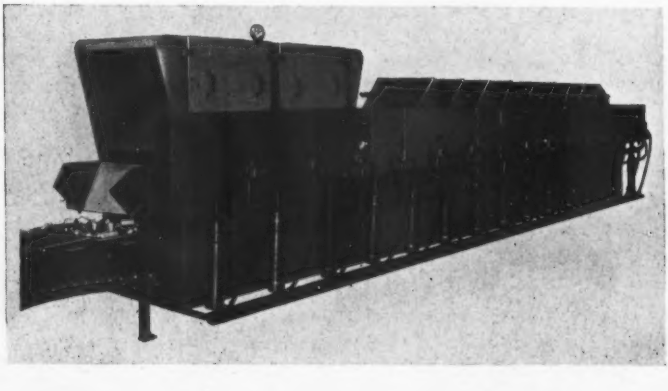


Fig. 1.—Automatic tipping basket plant.

in the Midlands, **R. J. Richardson and Sons Ltd.,** and in Scotland, **Balbardie Ltd.** The adaptability of both airless and air-operated shot- and grit-blasting and liquid abrasive honing was very effectively demonstrated by a number of full-scale working models. It is clear that there is still considerable scope for the reduction of finishing costs by the wider adoption of these processes, making full use of the different varieties of abrasive media available, including the soft grits.

An interesting and specialized application of blast cleaning was demonstrated by **Vacu-Blast Ltd.,** in the form of equipment which, operated by compressed air, is suitable for use anywhere on the workshop floor without interfering with other operations in the vicinity. The Vacu-blast Junior, specially designed for the preparation of surfaces for painting, is a new moderately priced machine of interest to the smaller type of works. Any air compressor with a capacity of 105 to 110 cu. ft. per min. can be used to operate the machine at a nominal pressure of 100 lb. per sq. in. and all abrasive and dirt is confined within the gun. A high-power air-ejector suction system picks up all abrasive and dust from the blasting area and conveys them to the reclaimer-separator. The blasting action is continuous with no delay required for re-cycling or re-charging. The special reclaimer-separator extracts dust and dirt which is removed to a dust jar while the abrasive collects in the bottom of the reclaimer for re-cycling. The entire unit weighs only 100 lb. and is mounted on a stand fitted with castors so that it is easily and quickly moved to wherever it is needed. The machine is 4 ft. high and occupies only 5 sq. ft. of floor space.

Another mechanical finishing technique, which can be used as a means of greatly reducing polishing times and cost is barrel finishing, and the diverse applications and close control which can be achieved by the utilization of modern barrelling methods was effectively demonstrated on the stand of **Roto-Finish Ltd.**

This company were showing on their stand two of the machines they have developed for mechanized deburring, descaling and polishing of parts pressed or cut from sheet metal. The two machines which were being shown were—the medium-size machine, Model DW 22/36/1 (Fig. 2) which has a work load capacity of approximately 200 lb. weight of metal components and a floor area of 5 ft. by 4 ft., and the smaller DW 16/16/2 which has a work load capacity of approximately 24 lb. of metal components with a floor space of 34 in. by 40 in.

In addition to supplying mechanical finishing machines, the company also provide a comprehensive pilot processing service which saves the manufacturer the trouble and expense of all experimental work.

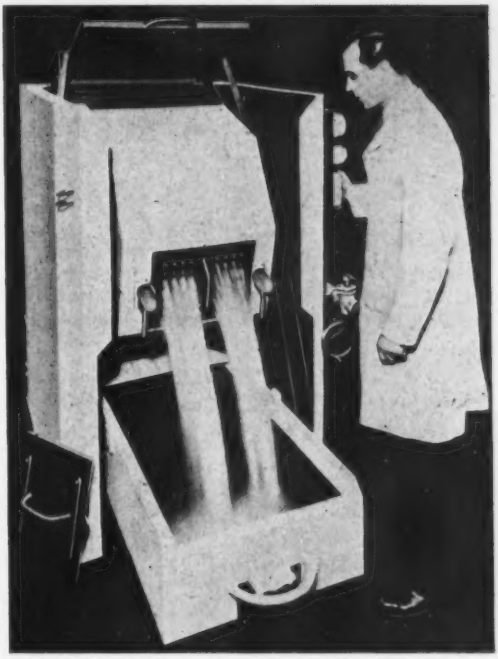


Fig. 2.—Equipment for mechanical deburring, etc.

All Roto-Finish machines are ruggedly-built to withstand hard and continuous work. They are closed at the sides and the front is protected by a safety guard which is in circuit with the operative switch, thereby conforming to all factory safety regulations. In addition to the ordinary operating switch there is a built-in pre-set automatic time switch so that the machinery may be set in action and will stop itself after a predetermined period without any attention from the operator.

The question of adequate ventilation of finishing shops, and particularly the problem of coping with noxious and corrosive fumes is of increasing importance today. The evolution of some of the modern plastic materials has placed in the hands of fan and ducting manufacturers materials which can stand up effectively to the mechanical and chemical demands made upon them. This was typified on the stand of **Keith Blackman Ltd.,** where three examples of the company's range of Tornado fume removal fans moulded in rigid P.V.C. were on show. These fans were representative of two distinct types *viz:*

(*a*) Series I: moulded fans, direct driven by K.B. made, totally enclosed motors and available in three sizes, Nos. 1, 2 and 3 (6-in., 12-in, and 18-in. dia. impellers respectively).

(*b*) Series II: fabricated fans with indirect pulley drive. These are an equivalent range to the company's fan type and incorporate a sixteen-blade, forward-curved multivane impeller. Size range is from No. 15 to No. 42 (*i.e.*, with impeller dias. of from 15-in. to 42-in. approximately).

These fans are a new development on exhibition for the first time.

Several other fans of various types were also on the stand including an operating 9-in. dia. type E.F.2 Extravent window fan.

Another exhibit on show for the first time on this stand was the Keno hydro-rotor industrial wet washer for removing finely divided dust particles from air streams as, for example, from grinding, polishing and buffing machines, paint spraying booths, etc.

This new development comprises a water tank, rotating helix and squirrel cage, set of eliminator plates and either an axial or centrifugal fan. In operation, the water is elevated from the tank by the helix and discharged radially, at high velocity through the squirrel cage, ensuring thorough wetting and trapping of the dust particles. Drain water from the top section provides a curtain of water over the unit's inlet. The Keno wet washer may be supplied in various arrangements to suit the particular application as, for example, with scraper bottom and/or continuous sludge filter. Other applications in compact form, include its use as an industrial air conditioning washer or humidifier.

Another demonstration of the application of modern plastics technology to the finishing industry appeared on the stand of the Nobel Division of **I.C.I. Ltd.,** where the application of a number of silicones of varying types was featured; in particular I.C.I. silicone resin R.240 is highly heat-resistant, and used in the formulation of paints in conjunction with heat-resistant pigments, it will provide a surface capable of withstanding a temperature of 300°C. for long periods. When used with aluminium pigment it provides a paint which will stand up to continuous exposure to 600°C. Applications for paints based on this silicone resin can be readily imagined and include space heaters, metal chimneys, exhaust manifolds and engine casings.

Other means for the protection of metal surfaces from corrosive attack at high temperatures could be studied on the stands of companies marketing metal spraying equipment. For example, **Metallisation Ltd.,** showed a number of examples of components which had been subjected to the Aluminizing process patented by the company. This process, which involves the application of an aluminium/cadmium alloy by spraying, is suitable for application to steel and wrought iron as well as many cast irons and to copper, bronze, nickel alloys, and nickel/chromium alloys. In the case of the two last mentioned materials it affords valuable and lasting protection against attack from sulphur bearing gases. The process has established itself, over many years application in this country, and lends itself to a wide range of applications, *e.g.* carburizing boxes, exhaust manifolds, salt baths, vitreous-enamelling perrets, annealing covers, etc., etc.

On the stand of **Metallizing Equipment Co. Ltd.,** the Metco metallizing systems were featured. These embrace a range of different specifications for composite finishes involving a sprayed metal coating followed by a suitable organic coating according to the conditions under which the component would be used in service. Metcolizing, specifically designed for the protection of iron or steel surfaces at high temperatures can be applied as one of a range of three available processes designed to cope with increasingly severe conditions.

Ultrasonic Cleaning

A particularly interesting new development which was exhibited on the stand of **Mullard Ltd.,** was the application of vibrations of ultrasonic frequency to the solvent cleaning of components.

Ultrasonic cleaning has been successfully employed in several different fields of industry. Among its applications are included the rapid removal of contamination from small fabricated metal parts, precision gear trains and their associated pivots, ball races, optical lenses, etc. In particular, this method is invaluable for removing contamination from areas on complex shaped parts which would otherwise be inaccessible, from optical polished surfaces which might suffer damage from normal cleaning methods, and for applications where speed in cleaning is a predominant factor. One specialized application is the dispersion of local graphite stains from synthetic fibres and fabrics such as rayon, nylon, etc.

The apparatus consists of an ultrasonic generator which drives a megnetostrictive or quartz type of transducer. The transducer vibrates at a high frequency and is coupled into a small cleaning tank containing a suitable cleaning fluid. Several methods of coupling are employed depending upon the nature of the contamination and the article to be cleaned.

Two general methods are employed, one using frequencies at the lower end of the ultrasonic band (l.f. ultrasonics) and the other using frequencies at the upper end (h.f. ultrasonics). The cleaning fluids are usually either detergents or solvents and are chosen to suit each particular application.

Generally, l.f. ultrasonics, employing a nominal

frequency of 25 kc per sec. are used for the removal of hard films such as lacquer, shellac or old resistant oil films, and the dispersion of graphite stains from synthetic fabrics. One particular application includes the speedy removal of mounting, polishing or protective lacquers from optical lenses, using a suitable fluid. The effect of cavitation (more easily produced at the lower end of the ultrasonic spectrum) increases the wetting action at the interface of the contaminant and the work, causing the film to flake off.

H.F. ultrasonics, using frequencies of the order of 1 Mc per sec. are usually employed for removing loosely adhering particles from otherwise inaccessible areas of small articles, such as swarf trapped in a ball race, or at the bottom of a tapped hole, or buffing compounds lodged in crevices or holes as the result of machine polishing, etc. The ultrasonically activated solvent quickly removes the grease film, and the h.f. vibrations, in producing high particle acceleration, shake free the loose particles.

In general the activation produced in the fluid is limited to the immediate vicinity of the transducer, although much greater penetration is obtained using h.f. techniques. Multiple transducer arrays are necessary therefore in many cases. Even so, in order to obtain economical working, it has been essential to hand-dip single articles, or to conveyor-feed the parts through the activated zone. Only in the case of very small articles such as watch parts, needles, screws, etc. can cleaning be carried out in bulk containers.

The ultrasonic cleaning equipment on show had been manufactured by Mullard Ltd. and Kerry's (Engineering) Co. Ltd. It was designed for the automatic cleaning and degreasing of small metal precision components such as ball and roller bearings, watch and instrument movements and other similar parts which, by the processes involved in their manufacture, are particularly susceptible to dust and swarf inclusions which detrimentally affect their working. The equipment is arranged so that cleaning may be done either in the component or the assembled state or both.

Baskets containing the uncleaned articles are automatically loaded on to the conveyor chain, pass through a pre-wash tank, an ultrasonic cleaning tank and a hot vapour drying zone, and are automatically off-loaded from the conveyor at the "clean" end. The equipment is completely automatic in operation, and allows 15 seconds in the ultrasonic tank, the conveyor being stopped for this period. Non-standard conveyor equipment can be supplied to suit individual users' requirements.

The pre-wash tank has a low flow rate, the liquid passing to a still, where it is evaporated and condensed. The grosser contamination is removed in this tank.

Clean condensate from the still is pumped to the ultrasonic cleaning tank where the solvent is continuously filtered by a pumping circuit. The overflow passes to the pre-wash tank, and is then returned to the still.

The ultrasonic energy is applied to the cleaning tank by four barium titanate transducers which derive their power from a standard Mullard 2 kW H.F. ultrasonic generator type L187. Suitable liquids are trichlorethylene, perchlorethylene or similar organic degreasing agents.

Thickness measuring instruments of various types were the principal exhibits on the stand of **Solus-Schall Ltd.**, including the layer thickness gauge (Type 2090). This apparatus is designed to measure the thickness of non-ferromagnetic layers on a ferro-magnetic base. Thus, non-ferrous metal plating, including hard chrome, galvanizing cadmium and copper can be measured as well as paint, lacquer and enamel layers. Nickel layers on steel cannot be measured with this apparatus. A special test head can be supplied for measuring chrome layers on very narrow specimens such as piston rings.

The test head is a very small magnetic yoke with primary and secondary windings. If the open yoke is brought near a steel sheet the voltage in the secondary winding will increase because of the reduction in demagnetizing effect, and this voltage will reach its maximum when the head is in contact with the steel. The voltage in the secondary coil is, therefore, a function of the distance between the base and the measuring head, and can be used, therefore, to measure the thickness of any superimposed plating layer. This secondary voltage is fed into a bridge circuit and is initially balanced for an unplated specimen. Out-of-balance voltages caused by separation of the head from the base are amplified and fed to a large meter, calibrated directly in layer thickness values. Two scales are provided for a full range coverage and calibration standards supplied for each range. Standard ranges are 0 to 0.002 in. and 0.002 in. to 0.012 in. Other ranges can be supplied on request. The accuracy of measurement is 2 per cent of the full scale deflection of the meter.

Also exhibited was the Isometer (Type 2080). This apparatus is designed to measure the thickness of non-conducting layers on a non-ferrous base. Thus layers of lacquer and paint, vitreous enamel, ceramics plastics and anodized coatings on light alloys, copper alloys, zinc and its alloys and austenitic steels can be measured. The equipment is not suitable for the measurement of metallic coatings on non-ferrous bases.

Another exhibit was the plating-thickness gauge

Fig. 3.—Sander-grinder.

(Type MaS/P). This gauge serves for the measurement of the thickness of non-magnetic layers on a magnetic base. The range of thickness covered is 0 to 0.5 mm. In particular it is suitable for the measurement of the thickness of:—

(*a*) Copper, zinc, chromium, paint, lacquer and enamel coatings on iron;

(*b*) Foils made of paper, plastics and non-magnetic metals;

(*c*) Non-magnetic plating on iron.

Water Treatment

Particularly interesting was a small twin deionization plant shown in operation by John Thompson-Kennicott Ltd. on the stand of **John Thompson Ltd.** This type of plant has been developed by the company to produce water of the very highest purity for modern power station plant and certain industrial processes where this degree of purity is required. The degree of purity achieved is equivalent to or greater than that obtained by techniques dependent on evaporation and condensation. The cost of the process, however, is about 2s. 6d. per 1,000 gallons as against about 5s. 6d. in the case of evaporation techniques.

The process employs pressure vessels containing synthetic resins, the contained salts in the raw water being converted to acids in one vessel and the acids being removed in the second vessel. The resins in these cation and anion exchangers are regenerated by acid and alkali treatment respectively.

The ion-exchange vessels and their pipework are constructed of rubber-lined mild steel. Pumps or injectors are used for adding the reagents and the whole process can be made automatic.

The chemical engineering department of John Thompson (Dudley) Ltd. were showing exhibits representative of their work in the field of pickling and acid-recovery plant. A working model demonstrated a rotary process plant supplied for pickling coiled strip. A full-scale pickling cage used in this plant was available for inspection, together with a measuring vessel and an example of a lead-covered copper coil for steam heating the acid baths. A model of a complete acid-recovery plant was also on show.

The metal-finishing division of **Atlas Diesel Co. Ltd.**, were represented on the company's stand by a comprehensive range of paint spraying equipment, including the Ecco hot-spray plant recently developed.

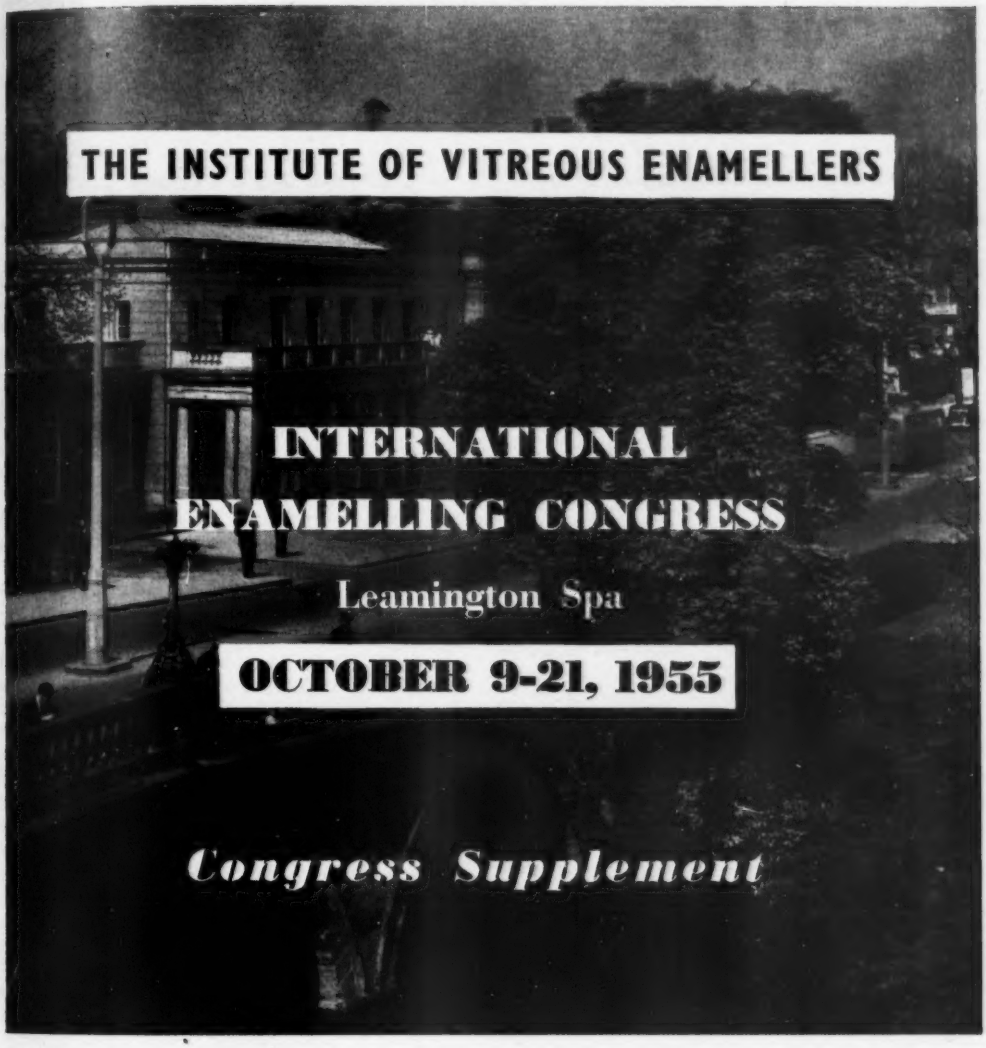
Among the mechanical finishing tools on the stand was the LSS-61 Sander and Grinder, a new pneumatic tool designed primarily for sanding, wire brushing and cup wheel grinding (Fig. 3). Two types of pad are available for sanding—the flexible rubber pad for dressing curved surfaces; the other type of backing is a semi-flexible disc of synthetic resin bonded discs supported by a cushioned backing plate. Both types are used with $\frac{7}{8}$-in. bore discs. The semi-flexible disc is very effective when used on flat surfaces and is both superior and more economical than the felt-backed depressed centre discs used with earlier machines.

Rozalex Ltd. were exhibiting the full range of their industrial protective barrier creams and skin-conditioning ointments. The restyled Rozalex Dispenser was also on show; this is specially designed for issuing a controlled and uncontaminated supply of Rozalex wherever required.

New barrier creams were featured which are developments from the continuous research and investigations by the company, each designed to combat specific hazards which have, hitherto, presented problems. Three of these new creams are of particular interest to the metal-finishing industry, *viz.*:—

No. 9.—A water-resistant cream which, on drying, as after application to the skin, provides a definite flexible film with a "tough" resilient texture. It is particularly suitable for use against organic solvents, and has been shown to have a high degree of efficiency against dye intermediates,

(*Continued in page* 404)



For the guidance and interest of those of our readers who are attending the International Enamelling Congress, the following pages contain information relating to the Programme, together with very brief synopses of the papers to be presented at the technical sessions.

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To all delegates their ladies and their guests we wish a happy and successful Congress, while for the benefit of the larger number interested in the work of the I.V.E., but unable to be present, our November issue will carry a detailed report of the Congress proceedings and functions.

THE INSTITUTE OF VITREOUS ENAMELLERS

2nd INTERNATIONAL ENAMELLING CONGRESS, 1955

AS previously announced the Institute of Vitreous Enamellers is marking the twenty-first anniversary of its foundation by staging the second post-war International Enamelling Congress. The first Congress was held in September, 1948 at the Piccadilly Hotel, London, and was attended by some fifty overseas delegates.

Following the programme of technical sessions and works visits in the London area, overseas delegates were conducted on a post conference tour of enamelling works in other parts of the country.

This first Congress, in spite of being staged during the austere early post-war period, was markedly successful and since that time the Institute has enjoyed very cordial relations with its Kindred Associations and industries overseas.

The second International Congress, which opens this year in London, on October 9, will in many ways follow a similar pattern to the previous one on a greatly enlarged scale. The growth of the industry, both in this country and overseas in recent years and the preliminary expressions of interest in the Congress, would lead to an anticipated attendance of over 500, about one third of whom may be overseas delegates.

The technical sessions at which some sixteen papers of both U.K. and overseas origin are being presented will be staged in the Town Hall at Leamington Spa. Nearly all the papers to be presented during the meeting are being circulated as preprints to registered Conference delegates, and will be subsequently published, together with a report of the ensuing discussions, in METAL FINISHING JOURNAL. A full report of the Conference and some of the social highlights will be published in our November issue.

As an aid to those attending the technical sessions some of the salient points from the technical papers are abstracted and printed in the appropriate sessions in the programme below.

The organizing Secretary of the Congress is the Secretary of the Institute, Mr. J. D. Gardom, John Gardom and Company, Ripley, Derby, to whom any last minute enquiries concerning the organization should be addressed.

PROGRAMME

Sunday, October 9,

2.00 p.m. to 5.00 p.m. Registration at the Congress Office, Park Lane Hotel, London, W.1.

7.30 for 8.00 p.m. Reception and Inaugural Congress Dinner to overseas delegates by the President and Council of the Institute of Vitreous Enamellers at the Park Lane Hotel, London, W.1. Cocktail Dress.

Monday, October 10,

Coaches depart Park Lane Hotel for Works Visits as follows:—

9.00 a.m. 1(*a*) R. and A. Main Ltd. (morning)
and
(*b*) Belling and Co. Ltd. (afternoon)

9.00 a.m. 2(*a*) R. and A. Main Ltd. (morning)
and
(*b*) Benjamin Electric Ltd. (afternoon)

9.15 a.m. 3 Electrolux Ltd. (all day).

9.00 p.m. to 10.30 p.m. Reception to overseas delegates by the Chairman and Committee of the Southern Section of the Institute at the Park Lane Hotel, London, S.W.1. Informal dress.

Tuesday, October 11,

9.00 a.m. Coaches depart Park Lane Hotel for visit to works of The Pressed Steel Co. Ltd.

4.30 p.m. approx. Depart Oxford for Leamington Spa.

9.00 p.m. to 10.30 p.m. Reception to overseas delegates by the Chairman and Committee of the Midland Section of the Institute at The Royal Pump Room, Leamington Spa.

Wednesday, October 12,

9.00 a.m. Annual General Meeting of the Institute of Vitreous Enamellers at the Town Hall, Leamington Spa.

10.00 a.m. First Technical Session. Presentation and discussion of papers Nos. 1-2. Town Hall, Leamington Spa.

Abstract No. 1

Enamelled Panels in Kitchen Units

By A. A. F. F. Buck

THE manufacture of sheet-steel kitchen units is meeting an increasing demand in Belgium and the adoption of white vitreous enamel as a finish has provided adequate protection against kitchen atmospheres. Production is mainly of door-panels, side-panels and sinks assembled into stove-enamelled body units.

It is hoped that standardization and mass production of units will lead to price reductions in the future, and that a range of coloured enamel finishes will be available.

* * *

Abstract No. 2

Porcelain Enamel in Building Construction in the U.S.A.

By W. N. Harrison

THE status of porcelain (vitreous) enamelled metal as a building material, specifically in the United States, is described. A brief historical background is followed by references to recently completed buildings and several that are under construction. A limited discussion is devoted to the outlook for further development during the next decade.

Quantitative data and qualitative reports are cited with reference to the performance of porcelain enamelled steel panels that have been exposed to the weather for extended periods, both on test stands and on the exterior walls of buildings. A short description of the mechanism of weathering is included.

Instances are cited showing the wide variety of uses to which porcelain enamels have been put in building installations. Typical examples of construction details are shown, including methods of design and construction for waterproofing, and types of insulation incorporated into wall assemblies. The growing importance of curtain walls and the use of porcelain enamels as durable finishes for them are outlined.

Specifications and test methods for architectural enamels are discussed, as well as opportunities for creative departures from designs that are suited primarily to other media. The material presented is illustrated by several slides showing engineering details and a number showing installations in colour.

* * *

Coaches depart Town Hall, Leamington Spa for Works visits as follows:—

11.45 a.m. 1. The Parkinson Stove Co. Ltd., Stechford, Birmingham.

11.45 a.m. 2. J. A. Jordan and Sons Ltd., Bilston.

12.00 noon 3. Sidney Flavel and Co. Ltd., Leamington Spa.

9.00 p.m. to 12.00 midnight. Civic Reception by Mayor and Corporation of Leamington Spa. Evening Dress.

Thursday, October 13,

9.00 a.m. Second Technical Session. Presentation and discussion of papers Nos. 3-5 Town Hall, Leamington Spa.

* * *

Abstract No. 3

Some Aspects of Vitreous-Enamelling Practice in Australia

by A. R. Williams

AT the present time there are 6 continuous furnaces and 75 box-type furnaces operating in all Australian States. Of the continuous furnaces 5 are of the electrically fired " U "-type, and one is a 7-burner " U "-type, oil fired. The box-type furnaces are either electric or oil fired, the electric type predominating. There are altogether 40 firms engaged in enamelling, producing numerous stock lines in sheet and cast iron. The wide variety of items processed has caused the introduction of strict control throughout the various enamelling departments.

Checks are constantly carried out to determine the enamelling characteristics of the irons used, and revised enamelling procedures formulated for inferior grades.

In cleaning procedure the trend is to replace the soda-borax bath with sodium-cyanide neutralizer. Small plants however, still grease burn and anneal. Milling practice is similar to that in other countries but for various reasons application methods vary. In the main, however, ground coats are applied by dipping or draining, but nearly all cover coats are sprayed, the exception being kitchen hollow-ware where application is by swilling. Most of the enamels used are titanium acid-resisting types. Self-coloured titanium frits are also used, the colour range at the present time being restricted to creams, buff, green and blue.

One of the main defects experienced in Australia was a pitting condition which was found to be caused by sulphur contamination, which acted as a flux. The paper reports the wide range of tests carried out on this defect and the limits defined for sulphur in the atmosphere.

Another problem has been experienced *viz.:* hard water which produces its main effect in the pickle room, where, for example, in the cleaner solution the tendency is to produce free acid compounds of the original soaps. Contamination is also produced in the rinsing solution, and calcium sulphate forms in the pickling solution itself. Hard water also produces curdy precipitates in the neutralizer, which drag out on the ware.

The solution to this problem has been the wide use of water softeners, mainly of the " Zeolite " type.

Abstract No. 4

Hydrogen Permeability of Steel and Its Relation to Enamellability

By S. E. Dahlgren

IT has long been known that hydrogen plays an important rôle in the enamelling process. Investigations at the National Bureau of Standards have verified the correctness of the opinion, earlier forwarded by several authors, that hydrogen mainly arises from the reaction between the steel base and the water combined in the enamel frits. It is unavoidable that commercial frits contain a certain amount of combined water. Eleven investigated frits had a water content of 0.12 to 0.31 per cent. Therefore the original source of the hydrogen cannot be eliminated. It has been pointed out that some frits are sensitive to too dry an atmosphere in the enamelling furnace. For best enamelling results a dew point of 5 to 10°C. has been recommended. Similar experience arises from the ceramic field. It is therefore possible that a certain water content in the frits may be beneficial in some other respects. The easiest way for the enameller to deal with the problem is—as usual—the steel. Its properties are of great importance in this connexion. The greater the amount of the produced hydrogen that manages to diffuse into the steel during the enamelling process, the more pronounced are fishscaling and reboiling, and the worse is the adherence. This would actually mean—the tighter the steel structure the better the enamellability.

The paper investigates the relations between hydrogen permeability in the steel, measured at about 40°C., and its gas content, metallographical structure, and analysis and how this corresponds to the enamelling results. In the measurement of the hydrogen permeability, there are several connexions with pickling problems.

The influence of inhibitors, surface conditions and the iron base on hydrogen diffusion is discussed and details are given of experimental determinations of hydrogen adsorption. Full details are also given of the technique adopted for evaluating the enamellability.

* * *

Abstract No. 5

Some Observations on the Incidence of Fishscales on Enamelled Steel Pots

By Ing. E. Messmer

THE output of heavy enamelled steel pots, etc., is often influenced to a great extent by the appearance of fishscales. To facilitate the interpretation of practical observations as well as the comparison of values, the programme of production at the author's works and the various operations involved are described.

Two types of pots and pans are manufactured *viz:* the lighter type for gas stoves, called " G ". pots and heavy pots and pans with concave bottoms called " E "-pots.

The great difference between the incidence of fishscaling on " G "- and " E "-pots over the whole production range is especially striking. The factors which from practical observation are found to be of great influence are the gauge of sheets, the area covered on both sides by enamel, the state of tensions in the system sheet-ground-cover-coat, as well as the bubble structure of the enamel.

Firing experiments with " G "- and " E "-pots showed the sides and bottoms of " G "-pots to have in all firing ranges a uniform firing stage. On " E "-pots sides are 2 minutes ahead of bottoms. In using a ground enamel poor in adhering oxides the examination of the gas-structure and formation of adhering layer on " E "-pots of high shape showed distinct differences between bottoms and overfired sides. Hereby the cause could be established why especially " E "-pots show a higher rate of fishscales. From the interpretation of the comparable values of appearance of fishscales on " E "-pots in the years 1953, 54 and 55 it appears that, besides the firing stage, the main cause of this defect is the capability of the sheet to absorb hydrogen, which can be reduced by ageing as well as by quality.

Large-scale experiments showed that pretreatment by annealing in controlled atmosphere of the raw pots as well as enamelling experiments with titanium alloyed steel sheets, again emphasized the significance of the steel sheet as base metal of enamel.

* * *

1.00 p.m. Buffet Luncheon, Town Hall, Leamington Spa.

2.00 p.m. Third Technical Session. Presentation and discussion of papers Nos. 6-8, Town Hall, Leamington Spa.

Abstract No. 6

Works Practice in Coloured Sheet-Iron Enamelling in Yugoslavia

by Ing. H. Ankerst

THIS paper is divided into three main sections, *viz:* coloured cover-coat enamels; some observations on decorating-type white titanium enamels with various colours and with liquid bright gold; and some observations of special enamelling procedures such as silk-screen printing and reverse printing on enamel using specially prepared vitrifiable colours.

In general, before the advent of the superopaque

titanium enamels, practice was to use a double coating technique which produced good cover with all colours. The comparatively thick layers produced by this technique made the articles very susceptible to damage by slight pressure or bumping. On the other hand the double-coating technique produced very smooth surfaces and increased resistance to abrasion.

Since with titanium white enamel only one cover-coat layer—and a rather thin one—is sufficient, much experimental work was required to evolve a technique for colour enamelling. It was found that the economy of titanium enamels combined with other colour enamels becomes significant only when a covering with coloured enamels is obtained such that a single cover coat is sufficient. Thus it was imperative to improve the covering power of the colour enamels, and success in this depends on the type of colour enamel used.

Generally, in colour enamels the author recommends the principle of colouring transparent frits with intense and " deep " colours. For brighter colours opaque frits are preferred and in certain cases, particularly with pastel shades, it is usual to add, in addition to the colour, an opacifier into the grinding mill. In general it is concluded that it is possible to intensify the majority of coloured enamels sufficiently so as to use them for a single coating.

The titanium " superopaque " enamels possess different properties to those of the " classical " opaque type quite apart from their higher covering power. One property is their lower surface tension which makes them unsuitable for stencilling work. The titanium enamels also have a high chemical reactivity with enamel pigments, which is shown by the production of a " breach " when a coloured enamel is sprayed on a white enamelled article. In general the best colour pigment is cadmium sulphide and higher melting point frits often produce better results than those with a low melting point.

Boron-containing titanium-enamelled articles when decorated with liquid bright gold show superior results to those obtained with classical " opaque " enamels.

In transfer and silk-screen printing on white titanium-enamelled surfaces the defect known as a " breach " is often produced. However, the same defect has been observed with a white powder enamel based on lead and arsenic, but was absent on " classical " cryolite or antimony-opacified enamels. Many of the vitrifiable colours when dust printed on enamel give pale colours; used for silk-screen, however, the colours are intense. An explanation of this phenomenon concludes the paper.

Abstract No. 7

An Investigation into the Viscosity of Enamels

By N. S. C. Millar, A.R.I.C., and C. H. Buck, B.Sc.(Hons.), F.P.S.

THE behaviour of enamels in production depends upon a variety of factors, summed up in the general term "Workability". Viscosity and surface tension are two important properties involved in this general term and in order to explore the mechanism of the enamelling process it is essential to study these factors separately.

The paper describes an apparatus which is being used for measuring the viscosities of enamels and some of the results which have been obtained. An attempt is also made to correlate viscosity measurements with flow, fusion point and firing range. The viscosity apparatus used is based on that designed by Lillie for the measurement of viscosities of glasses up to 1500°C. Viscosity curves for 11 frits are given and tables also give flow, fusion point and firing range.

The main conclusion to the work is that viscosity alone does not determine flow or fusion point and hence the "workability" of the enamel.

The general results obtained have been used to improve the "workability" of a superopaque titania enamel applied to cast iron. The original frit during smelting was extremely fluid and it was difficult to obtain a thread in the usual test for "batch freeness", the melt falling off the dip rod in drops. This frit exhibited excessive boiling when fired. By increasing the silica content of the frit the melt flowed from the dip rod as a thread and on firing there was complete absence from boil.

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Abstract No. 8

Some Investigations into the Co-efficient of Expansion of Vitreous Enamels

By N. F. Parker

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6.00 p.m. Visit to the Stratford Memorial Theatre.

Friday, October 14,

9.00 a.m. Fourth Technical Session. Presentation and discussion of papers Nos. 9-11. Town Hall, Leamington Spa.

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Abstract No. 9

The Development of Opacity in White Porcelain Enamels

by Professor A. I. Andrews

AFTER listing the definitions drawn up by the American Society for Testing Materials relating to reflectance and reflectivity, this paper explains the physical properties of enamel coatings which produce opacity.

In the development of maximum opacity or reflectance it is desirable to use low absorption materials with high differences of optical density between the particles and the glass and a good distribution of particles. Optimum particle size has been estimated at 0.25 microns.

Sources of opacifying particles in enamel include insoluble materials added to the glass, either in smelting or firing, *e.g.* SnO_2, ZrO_2, TiO_2, CeO_2; crystals formed from the glass either in smelting and cooling, or in firing and cooling, *e.g.* NaF_2, CaF_2, TiO_2, ZrO_2; bubbles, either entrapped by occlusion or developed by decomposition and chemical reaction of clay and/or organic materials.

Early enamels made use of fluorides, antimony and tin-oxide opacifiers, while zirconia and titania are modern developments. In special cases arsenic, cerium and bubbles were extensively used.

Opacification by fluorides arises principally from the presence of crystals of sodium fluoride, the fluoride radicle being added usually as cryolite, fluorspar, or sodium silico-fluoride. The amount of fluoride necessary to produce adequate opacity reduces acid resistance, therefore for many years mill additions of up to 10 per cent tin oxide were necessary.

The introduction of antimony, initially in amounts of up to 3 per cent, particularly in the presence of sodium nitrate, greatly improved both opacity and acid-resistance of these enamels. Soon afterwards, zirconia was found to be a useful opacifying mill addition and found extensive use.

Bubble opacity produced by adsorbing such organic material as methylene blue, resin, etc., on clay, with the addition of sodium nitrate and ammonium chloride at the mill, showed real promise and would probably have met with wider success had it not been for the reduction in scratch resistance of the enamel and the introduction of high-antimony super-opaque enamels. These contained up to 10 per cent antimony oxide with titania, calcium fluoride and sodium nitrite, and made possible reflectances of 70 to 75 per cent with thinner coatings and only about 2 per cent of opacifier added at the mill.

Zirconia super-opaque frits were developed in competition with these enamels and for many applications became very popular as the white colour was better. They did however, lack acid resistance.

Titania-opacified enamels developed shortly before the war had excellent hardness and good acid resistance, but tended to develop a cream or yellow colour on firing. Many troublesome problems were encountered by early workers in obtaining a uniform white and a stable reflectance with titania enamels until responsibility for the yellow colour was found to be due to the presence of traces of such elements as chromium and columbium.

Although control of colour still presents some problems, titania enamels have now almost entirely replaced the earlier types, except for such special uses as dry-process cast-iron enamelling. Present work is aimed at the reduction of firing temperatures of these enamels.

* * *

Abstract No. 10

An Account of Vitreous Enamelling Practice in a Danish Works

by O. Schroeder

THERE are in Denmark today some twelve enamelling works producing about 2,500,000 kg. of enamelled cast-iron and about 2,000,000 kg. of enamelled sheet-iron, mainly as household appliances, stoves, cookers, refrigerators, etc. The yearly consumption of frit is 700 to 900 tons. Most of the plants are small, only one operating a continuous furnace.

Some details are given of works practice in the new sheet-iron enamelling plant at the author's works, concerned largely with the production of pots, gas rings, cooker parts, casseroles and jobbing. Firing of both cast-iron and sheet-iron articles is carried out in electric furnaces, but rejections tend to run at about 20 per cent.

The increasing demand for pastel shades on household appliances has involved a change-over from castings to sheet-iron construction on cookers, and surplus foundry capacity has been taken up by the introduction of a range of cast-iron casseroles.

Sheet-iron pickling is carried out in cold hydrochloric acid and some use is made of nickel-dipping.

Sheet-iron perrets are made to a special design in heat-resisting, 25/20 chromium/nickel 16-gauge sheet, and to increase adaptability these are made with standard bases and interchangeable tops.

All slushing, spraying and shot blasting is paid on a piece-work basis, average earnings being 4*s.* 6*d.* to 5*s.* 0*d.* an hour. Fusers are paid 4*s.* 0*d.*, pickle shop and mill room personnel about the same. Transport and inspection labour receive a minimum of 3*s.* 2*d.* All workers are male, working a week of 48 hours.

* * *

Abstract No. 11

Ceramic Coatings for Use at High Temperatures

By B. Zick

THE application of vitreous-enamel coatings for protecting metals in industrial and

transport undertakings has to a large extent lagged behind the domestic appliance industries. Impetus was given however, by the advent of the jet engine, and development work was initiated by the U.S. National Bureau of Standards, for coatings for mild steels in order to conserve alloys which were in short supply. The development programme produced coatings of the A.19 and A.31 types based on frits of the conventional ground coat type with an increased refractoriness obtained by additions of, for example, zirconium oxide, titanium dioxide, ferric oxide, etc., etc.

A parallel programme of coating development for stainless and alloy steels was also initiated by the Bureau.

Developments by private firms resulted in, for example, the Ferro-Solaramic coatings which are easy to apply and fire at a comparatively low temperature. These coatings are also non-toxic and give protection up to 1,200° C. for short periods and 900 to 950° C. for prolonged periods. The coatings will also withstand acids, alkalis, salts, hot gases and combustion products. In addition they protect dielectrically and sharply reduce abrasion and wear.

The use of ceramic coatings confers many advantages, including improved fatigue life, inhibition of corrosion and oxidation, maintenance of ductility and tensile strength and because of their thinness, rapid heat transfer.

Alloys containing less than 20 per cent. nickel may be either gas or arc welded after coating, and if necessary parts may be machined after processing without serious chipping of the coating. In general, ceramic coatings are similar to glass as regards abrasion resistance, and are normally effective up to 650° C. However, special anti-gall coatings are available for use on components where abrasion takes place at higher temperatures.

Parts to be coated must be thoroughly cleaned and in the paper typical preparation procedures are given. Application of the coatings is by methods commonly used in vitreous enamelling. Where possible coating is done by dipping, but spraying is also used. The drying cycle is identical with that normally used in enamelling and firing is in muffle-type furnaces.

In order to ensure satisfactory service under very severe conditions a series of standard tests are carried out on each smelt of frit, milling of slip and processing bath of components.

Much progress has been made in this comparatively new field of metal protection and there are undoubtedly many further applications worthy of investigation.

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1.00 p.m. Buffet Luncheon. Town Hall, Leamington Spa.

2.00 p.m. Fifth Technical Session. Presentation and discussion of papers Nos. 12-14.

Abstract No. 12

The Estabiishment of Standards of Quality for Vitreous-Enamelled Ware

by J. M. Wijtenburg

THIS paper deals with the practical usefulness of standards of quality:

(*a*) as a means of guaranteeing to the customer a constant, fixed quality;

(*b*) as a source of detailed information for statistical quality control;

(*c*) as a means of comparing the quality of the home product with that of other manufacturers.

(*d*) as a means of judging the qualitative production results in the long run without any idealizing.

From a preliminary investigation of visual sorting it was concluded that selection with such vague standards is useless as a means of supplying consistent quality to the customer, and as a method of works quality control. Selection and sorting should only be by measurable quantities and the author describes the evolution of a system for the quality control of enamelled baths.

The system eventually adopted involved the definition and tabulating as diagrams of 18 defects, out of which 17 were measurable and are comparable. Standard inspection cards were developed, the method worked well and took up no more time than the previous methods used. Customers are told how a bath tub receives its selected quality class, and the completed inspection card relating to it, is retained on the files so that if complaints arise the card can be produced. This has been found to provide a good deterrent against superfluous complaints. By marking down on the inspection card the details concerning the manufacture of the specified tub, the card became a source of information for statistical quality control.

As a result of the adoption of the system it was possible to reduce many defects caused by, for example, the time elapsing between casting and enamelling of the bath, dust content of the enamelling shop atmosphere, shape of prongs on which the baths rest, etc., etc.

* * *

Abstract No. 13

An Account of De-Enamelling Practice in a French Works

by M. Camuset

THIS paper is concerned with de-enamelling procedure by immersion in molten caustic soda. Some general descriptive data on the

process as a whole is followed by a detailed review of the plant in operation at S.O.D.I.

An insulated welded steel tank is used, 1.2 m. × 1.1 m. × 1.2 m. deep, a space being provided at the bottom of the tank for a sludge tray. Sheathing above the tank for protection against splashing is insulated and equipped with two doors operated by automatic remote control. These doors are always closed when a load is lifted above the tank and remain closed until the load is removed from the tank. A fume hood is provided above the tank.

Heating is by radiant tubes immersed in the caustic soda, and each tube is fed with town gas by means of individual burners; products of combustion pass to an exhaust stack. This system allows the caustic to " freeze " if required without danger. Temperature control is automatic.

Components are immersed by means of a 6-armed rack; each arm holds a tray and the trays are lowered and raised as required by hydraulic jacks remote controlled. Details are given of the sequence of operations used with this " conveyorized " equipment.

Parts remain in the water wash for several hours, and are hand sponged also. After 5 tons of components have been de-enamelled the sludge is precipitated and the sludge tray removed by means of a pneumatic hoist carried in a mono-rail. New caustic is then added as required. After cooling the sludge is disposed of.

Every 5 to 6 weeks a " partial draining " of the tank to give more effective purification is carried out. The sludge is precipitated and the good caustic pumped into a " pre-heating " tank. Once all the sludge has run off the good caustic is sucked back into the main tank and new caustic added as required.

The labour force for a daily output of 2.5 tons in an 8-hour shift is 4 men.

This plant has been in operation for 4 years without accident, due to mechanical handling devices which eliminate, for the personnel, all dangers in the use of caustic soda.

* * *

Abstract No. 14

Some Investigations into the Acid Pickling of Mild Steel

By Jackson

THE first part of this paper is an account of some experimental work, carried out under laboratory " controlled " conditions, to compare the characteristics of 10 per cent sulphuric acid with 20 per cent hydrochloric acid as pickles for mild steel. A study was also made of the effects of variables such as temperature, inhibitors and ageing of the pickle, on the pickling process. In this particular case the object of pickling was the removal of scale with minimum attack on the metal for the subsequent operations of spot welding, painting and electrodeposition. The second part of the paper describes work carried out to study the effects of previous alkaline cleaning on the process of pickling.

The third part gives some results obtained in a short study of the nickel-dip process, and some other work which was done to improve the surface condition of steel after pickling.

The experiments show that 10 per cent sulphuric acid at 70°C. is roughly equivalent in pickling power to 20 per cent hydrochloric acid at 50°C., both in respect of annealing scale and gas-welding scale. An increase of 10°C. in bath temperature doubles the rate of acid attack in each case.

It is confirmed within the limits of the experiments that acid inhibitors, while limiting the rate of dissolution of steel, have no noticeable effect on the rate of scale removal. The efficiency of inhibitors is diminished slightly by the ageing of pickling baths but under the usual works conditions this can be neglected. In both sulphuric-acid and hydrochloric-acid pickles the presence of large amounts of dissolved iron increases the time necessary for scale removal.

Steel which has been degreased in an alkaline silicate solution is pickled at the same rate whether or not the surface has been rinsed free from deposited "silica" film.

Traces of nonionic surface-active agents, frequently constituents of commercial alkaline silicate cleaners, have been found to slow down slightly the rate of pickling (etching), but a small increase in bath temperature is sufficient to correct this. Variations in shop practice and local variations in the surface of the steel sheet may affect pickling rates more profoundly than these surface-active agents carried over from the cleaning bath. Therefore they can be considered harmless from the practical point of view.

Carry-over of the components of an alkaline silicate cleaner into the pickling tank has no apparent effect on the weight of nickel deposited in the subsequent nickel dip.

Throughout this paper the " significance " of results has been constantly borne in mind and for this reason the authors are reluctant to draw too detailed conclusions from the practical work carried out. Despite the care which was exercised at all stages of the work it is clear that even with the best control some variables remained uncorrected which prevented the close duplication of experimental results so often (quite wrongly) expected of laboratory work. It is hoped that a scientific approach to the practical operation of steel pickling will not be unappreciated by the

practical man who recognizes these anomalous occurrences.

* * *

7.00 p.m. Coaches depart from the Regent, Manor House and Clarendon Hotels to convey delegates to:—

7.30 for 8.00 p.m. Reception by the President and Chairman of the Institute followed by the Congress Banquet at Chesford Grange. Evening Dress.

Saturday, October 15,

10.00 a.m. Sixth Technical Session. Presentation and discussion of papers Nos. 15-16. Town Hall, Leamington Spa, ending at 12.00 noon.

Abstract No. 15

The Suitability of Fusion Welding Processes for Vitreous Enamelling

by B. Trehearne, B.Sc.

SOME of the factors influencing the quality of a high-grade titanium white vitreous enamel on fusion-welded sheet-metal components are considered in this paper. Tests were carried out on 18-s.w.g. enamelling quality sheet which was cut to 12 in. × 3 in. to give a 12-in. butt weld between two pieces. The test welds were dressed flat, ground and disced, X-rayed, and then cleaned prior to enamelling. The quality and cleanliness of the weld deposit affect the quality of the enamel finish on the weld zone, but apparently some good welds will not give fault-free enamel finishes.

Small percentages often of the order of less than 1/10 per cent of alloying elements in the steel, or filler wire, adversely affect the wetting power of the enamel on the steel and weld porosity is also a major defect. Of the four welding processes used, the two most suitable were found to be oxyacetylene and atomic hydrogen. With oxyacetylene, Armco iron filler wire provided a sound deposit without enamelling defects. It was found that in general the weld metal contained more total gas than the parent metal in the heat-affected zone; however, the hydrogen content in all samples was low as also was the total gas content. With atomic hydrogen there were no enamelling defects in welds made without filler rod and very few in the enamel over the autogenous welds.

Defects near the fusion zones were mainly due to reactions of the enamel with surfaces which were not completely chemically clean. Also the tight-clinging oxides formed in the heat affected zones adjacent to the welds were not satisfactorily removed by grinding, discing and pickling, but recourse to grease burning produced satisfactory finishes.

Abstract No. 16

The Development of Screen Printing in the Ceramic Industry

By F. E. Kerridge

SCREEN printing has developed rapidly in the glass industry, where its advantages of thickness of deposit and economical operation can be matched by no other process. Its use, both direct and in transfer form, has resulted in an enormous increase in the production of enamelled glass, particularly of containers, tumblers, stemware and glass signs. Future developments are likely to be improvements in quality and a reduction in costs resulting from mechanization of the printing operation made possible by the introduction of the thermoprinting process.

Development in the pottery industry of the direct printing process has been slower because of several factors, the most important of which are limitations imposed by the variety and shape of the ware and the existence of other processes which, although more laborious in operation, give better definition and registration. The development of the direct process seems likely to be confined largely to the printing of single and simple two-colour designs on ware of standardized shape.

Screen-printed transfers do not suffer from the limitations of the direct process since they are printed on a flat surface and can be applied to irregular shapes. They are finding increasing use in the Potteries and the improvements which have been made in the short time they have been available would suggest that further development can be expected.

The direct screen process is used in the vitreous-enamelling industry mainly in the production of signs and badges. It is seldom used purely for decoration owing to the utilitarian nature of most enamelled ware.

The use of plastic in the kitchen is increasing, largely at the expense of enamelled iron; this ware is often more expensive and less durable and presumably sells because it is colourful and decorative. The greater use of screen printing and other decorating processes to enhance the appearance of enamelled iron ware might provide an answer to this competition.

The existing method of firing decorated enamelled iron, in which the base enamel is re-melted does not give consistently good results with transfers and imposes difficulty in the use of liquid gold and other metallic and lustre decoration. A modified firing technique in which the base enamel is not re-melted might be practicable and might improve the quality of decoration and make available an extended range of decorative effects.

6.00 to 7.30 p.m. Reception by invitation of the President of the Institute and Lady Briggs.

Sunday, October 16,

10.00 a.m. Coaches depart Leamington Spa for Manchester, Luncheon being arranged *en route*.

Monday, October 17,

Coaches depart Midland Hotel, Manchester for works visits as follows:—

9.00 a.m. 1. John Summers and Sons Ltd., Shotton, Chester.

10.00 a.m. 2. Richmond Gas Stove Co. Ltd., Warrington.

6.30 to 8.00 p.m. Reception to Overseas delegates by the Chairman and Committee of the Northern Section at the Café Royal. Peter Street, Manchester. Informal Dress.

Tuesday, October 18,

10.00 a.m. Coaches depart Midland Hotel, Manchester for Morecambe, visiting one of the following works *en route:*—

1. English Electric Co. Ltd., Bradford.
2. Stoves Ltd., Rainhill.

Wednesday, October 19,

9.30 a.m. Coaches depart Morecambe for Edinburgh, Luncheon and Tea being arranged *en route* arriving at approx. 6 p.m.

7.00 to 8.30 p.m. Reception to Overseas delegates by the Chairman and Committee of the Scottish Section of the Institute at the George Hotel, Edinburgh. Informal dress.

Thursday, October 20,

Coaches depart George Hotel, Edinburgh for works visits as follows:—

9.00 a.m. 1. Carron Co., Falkirk.

9.00 a.m. 2. M. Cockburn and Co. Ltd., Falkirk.

Returning to Edinburgh at approx. 3. p.m.

4.00 p.m. Civic Reception by the Lord Provost and the Corporation of the City of Edinburgh.

Friday, October, 21,

9.00 a.m. Coaches depart George Hotel, Edinburgh for visit to one of the following works:—

1. Smith and Wellstood Ltd., Bonnybridge.
2. Mitchell, Russell and Co. Ltd., Bonnybridge.
3. British Aluminium Co., Falkirk.
4. Grangemouth Petroleum Refinery, Grangemouth.

7.30 for 8.00 p.m. Congress Terminal Dinner, at the George Hotel, Edinburgh. Cocktail Dress.

LADIES' PROGRAMME

In addition to all the social functions and receptions listed in the general programme, to which all Ladies accompanying delegates are invited, arrangements have been made for the entertainment of ladies during many of the works visits and technical sessions. Some of these special ladies functions are listed below:—

Tuesday, October 11,

9.00 a.m. Coaches depart Park Lane Hotel, for visit to Blenheim Palace.

4.30 p.m. approx. Depart Blenheim Palace for Leamington Spa.

Wednesday, October 12,

11.00 a.m. Display of Millinery and accessories by Bobby and Co. Ltd.

1.00 p.m. Luncheon at the Regent Hotel, Leamington Spa.

Thursday, October 13,

10.00 a.m. Coaches depart Town Hall, Leamington Spa for visit to Bourton on the Water and Compton Wynyates.

1. p.m. Luncheon at the Unicorn Hotel, Stow on the Wold. Return to Leamington at approx. 4.30 p.m.

Friday, October 14,

10.00 a.m. Coaches depart Town Hall, Leamington Spa for visit to Warwick Castle and the Leicester Hospital.

1 p.m. Luncheon at the Warwick Arms Hotel, Warwick. Return to Leamington Spa at approx. 3 p.m.

Monday, October 17,

9.30 a.m. Coaches depart Midland Hotel, Manchester, for visit to the Works of Josiah Wedgwood and Co. Ltd., Darlaston.

1.00 p.m. Luncheon at the North Stafford Hotel, Stoke-on-Trent. Return to Manchester at approx. 5.30 p.m.

Friday, October 21,

10.00 a.m. Coaches depart George Hotel, Edinburgh for excursion through the Trossachs, luncheon being arranged *en route* and returning to Edinburgh at 3.30 p.m.

Engineering and Marine Exhibition

(*Continued from page* 394)

plastic materials, printing inks, duplicating inks and carbons, synthetic resins and glues.

No. 10.—Developed particularly for use when in contact with explosive materials or substances which are known to have a high rate of toxic absorption through the skin.

No. 11.—This barrier cream is particularly satisfactory against paints, varnishes, heavy oils, but, as it is water-soluble, it is not suitable for use under "wet" conditions of work. This means, specifically, conditions where the worker would normally be called upon to immerse his hands in water during the period when in contact with the material already mentioned, and would not include atmospheric moisture, perspiration, etc.

FINISHING

NEWS REVIEW

CANADA'S FIRST TiO_2 PLANT

THE National Lead Company, through its subsidiary Canadian Titanium Pigments Ltd., will construct Canada's first titanium pigment plant on a site near Varennes, Province of Quebec, on the south bank of the St. Lawrence River about fifteen miles north-east of Montreal. The new plant is designed to meet Canada's entire requirements for titanium oxide and will cost approximately fifteen million dollars.

Titanium pigments are used extensively by the paint, rubber, plastics, paper and other industries to add whiteness, brightness and opacity to their products. Since titanium pigments were first introduced into Canada by the Canadian Titanium Pigments Ltd. in 1927, the demand for them has increased steadily each year and Canadian manufacturers have used increasing quantities, imported chiefly from the United States.

The new titanium pigment plant will require approximately 750 workers at the peak of construction which will occur in the fall of 1956. Production is expected to begin in 1957 and the plant will give employment to about 400 people.

CHEMICAL NICKEL PLATING

THE Kanigen process of electroless chemical nickel plating will be available in 1956 in the United Kingdom. Albright & Wilson Ltd., have signed an agreement with the General American Transportation Corporation who developed the Kanigen process, whereby they become the sole licensees for the U.K., Eire, and Denmark.

Kanigen plate is an entirely new material which can be applied to metal, glass, plastics and ceramics and provides a uniform, hard, non-porous coating on components of any shape; it is a nickel-phosphorus alloy containing about 8.5 per cent of phosphorus.

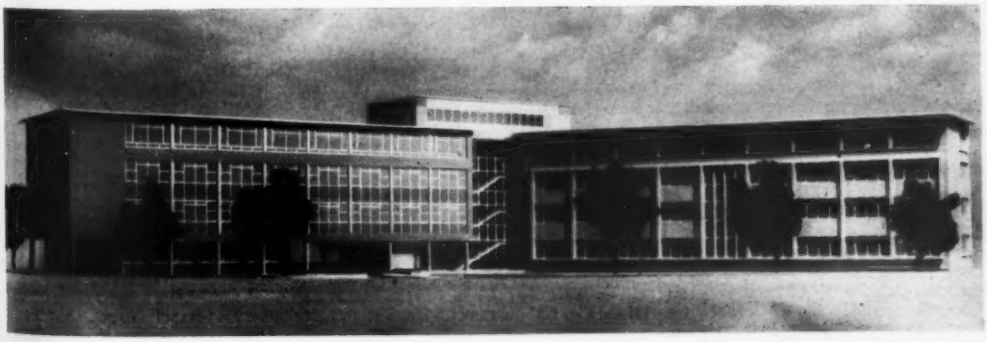
A display of components which have been coated with Kanigen plate will be found on the Albright & Wilson stand (Forum Stand C.52) during the British Trade Fair at Copenhagen, from Sept. 29 to Oct.16.

NEW HEADQUARTERS FOR I.C.I. PAINTS DIVISION

WORK will start shortly on a 4½-acre site in Wexham Road, Slough, where a new office building is to be erected for the headquarters departments of I.C.I.'s Paints Division. The new building will be across the road from the Division's Slough factory, with which it will be connected by a tunnel. The building will have a "Y" shaped plan which has advantages for office organization and minimizes interference with light and transmission of noise between wings.

The building will have a total floor area of over 70,000 square feet, arranged on four floors, and it is planned to accommodate a staff of approximately 500. It will be equipped with high-speed lifts serving all floors, and fluorescent lighting will be installed throughout. The internal sub-division of each floor will be by demountable partitions to facilitate subsequent changes in office organization. Ceilings and partitions will have acoustic treatment to reduce noise to a minimum. The building frame is to be in reinforced concrete, the prestressed beams and floor joists being arranged to maintain a clear floor to ceiling height throughout the working space, by eliminating transverse beams. The extensive area of windows will provide light and pleasant working conditions. The main cladding of the building is of brickwork, but the design incorporates modern, light, cladding materials.

It is expected that the headquarters will be ready for occupation early in 1957.



OBITUARY

Evans: Mr. Howard Evans, A.M., F.I.M. died suddenly on September 11. Mr. Evans who was educated at Sheffield University where he gained the Mappin Premium was Superintendent of the development and research laboratories of The Mond Nickel Co. Ltd., Birmingham. Mr. Evans was 48.

* * *

Webb: Mr. F. Ernest Webb, founder and managing director of Aerostyle Ltd., died on August 3 at the age of 76. Mr. Webb was one of the British pioneers of spray painting and was himself an artist with the spray gun, many of his pictures produced by this method having been reproduced in the technical press. He was chairman of S.E.M.A. from 1937-1948 and from 1953-1955, president of B.C.A.S. in 1947, and an extremely active member of B.S.I. Committees.

TECHNICAL AND INDUSTRIAL APPOINTMENTS

Stewart and Gray Ltd., Paisley Works, Swains Road, Tooting Junction, London, S.W.17, have announced the appointment of Mr. T. J. McArthur to the board of directors of the company.

Mr. McArthur will be responsible for production, and his enamelling experience will also be utilized wherever necessary in the subsidiary companies of Stewart and Gray Ltd. This will include batch and production checks on all Escol frits.

Mr. McArthur has been intimately connected with the vitreous enamelling industry for over 25 years and his knowledge of enamelling and enthusiasm for new projects in the enamelling field we feel will strengthen the company's service to its customers.

* * *

The Right Honourable Osbert Peake, **Minister of Pensions and National Insurance**, has appointed Mr. Norman J. Campbell, S.S.C., director of the **National Paint Federation**, to be a member of the Industrial Injuries Advisory Council. The Council advises the Minister on proposals for regulations and on other matters referred to it by him,

TRADE AND TECHNICAL PUBLICATIONS

"Zinc Dust in Protective Coatings": This is the title of a fully illustrated booklet issued by the Zinc Pigment Development Association, 34, Berkeley Square, London, W.1. The booklet reviews the development of zinc metal pigmented paints, and describes their formulation, properties and applications. Paints containing metallic zinc dust as the pigment can claim to be among the older zinc-coating methods, but it is only in comparatively recent years that zinc-rich paints (those containing more than 93 per cent metallic zinc in the dry paint film) have been generally appreciated and developed in this country, where the number available on the market is rapidly increasing.

It is established that zinc-rich paints confer the same type of protection as the other better-known zinc coatings, and although paints cannot adequately replace them under all circumstances, they can be used where other methods of applying zinc are impracticable. Zinc-rich paints are anti-corrosive coatings which for efficiency will stand every comparison with other modern paints and, moreover, they offer the advantage of being completely non-toxic and so can be sprayed, brushed or applied by dipping. Zinc-rich primers, based on binders such as plasticised polystyrene, or chlorinated or isomerised rubber, protect steel under almost any normal conditions and in some particularly corrosive environments. When carrying suitable top-coats, they give outstanding protection against atmospheric corrosion. Paints based on inorganic binders or cements are also available and have already been used with considerable success overseas as marine primers and as single coat finishes for atmospheric exposure.

The older type of zinc metal pigmented paints, based on an 80/20 zinc dust/zinc oxide mixture, are usually formulated with reactive oleoresinous media and can be used as priming or finishing coats. Because of their good adhesion to zinc surfaces, they offer the ideal coating for the renovation of galvanized sheets, and, although they are not so suitable as the highly metallic type for marine immersion conditions, they are extensively used in the protection of iron and steel.

* * *

"The Chemical Background of the Aluminium Industry": This Monograph by T. G. Pearson, Ph.D., D.Sc., F.I.M., F.R.I.C., Director of Research of The British Aluminium Co. Ltd., and published by The Royal Institute of Chemistry, was issued to coincide with the 100th anniversary of the launching of the aluminium industry by Henry Ste. Claire Deville. The Monograph provides an outline of the commercial processes now used in extracting and refining aluminium and gives an account of their chemistry. It also takes stock of the massive accumulation of discoveries, inventions and researches that have so far failed, except in temporary political or special local circumstances to reach large-scale commercial development. Copies are obtainable from the Institute at 30, Russell Square, London, W.C.1., price 7s. 6d. net.

* * *

Metal Pretreatment: The August/September issue of "The Bonderizer," published by The Pyrene Co. Ltd., Great West Road, Brentford, Middx., highlights some unusual applications of the company's phosphating processes. Articles include the use of "Parco-Lubrite" as a base for molybdenum disulphide to reduce wear and maintain lubrication of massive moving surfaces, and also the effect of "Parkerized" steel and "Bonderized" aluminium surfaces in eliminating or reducing fretting corrosion.

CHANGES OF ADDRESS

British Titan Products Co. Ltd., announce that the address of their Birmingham office is now Stratford House, Stratford Place, Camp Hill, Birmingham, 12. The telephone number is VICtoria 3477.

* * *

The Council of Industrial Design have moved to 28, Haymarket, London, S. W. 1. Telephone : TRAfalgar 8000.

* * *

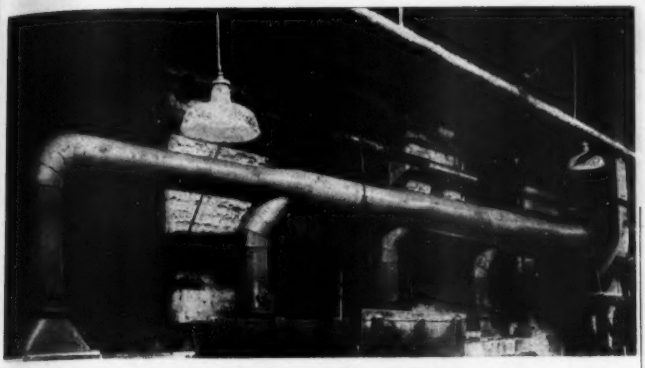
The Bristol branch of the **Atlas Diesel Co. Ltd.**, is now at 47a, Zetland Road, Bristol, 6. The telephone number is Bristol 45036 and the branch is under the managership of Mr. W. J. Clarke.

* * *

The sales office of the paints division of **Burt, Boulton and Haywood Ltd.**, has been transferred to the works address in order to give customers the best possible service by ensuring immediate liaison between sales and works. All enquiries and correspondence should now be sent to Crabtree Manorway, Belvedere, Kent. Telephone: Erith 3066.

* * *

Marb-L-Cote Manufacturing (Great Britain) Ltd., have moved their offices to 28-30, Chapel Street, Stratford, London, E.15. Telephone: MARyland 6034.



PLASTIC FUME EXTRACTION PLANT

The illustration shows a fume extraction plant with the exhaust ducting and fan constructed entirely from Rigid Polyvinyl Chloride (P.V.C.). This material has corrosive-resisting properties which make it virtually immune from attack by most alkalis and acids including sulphuric acid, hydrochloric acid and nitric acid.

Plants constructed in this material are therefore ideally suited for extracting fumes from pickling, plating, bonderising and other processes where corrosive acids and alkalis are used.

Extraction plants in Rigid P.V.C. can be designed and fabricated to suit individual requirements and further details may be obtained from R. N. Watson Ltd., 14 Ridgefield, Manchester 2.

INSTITUTE OF METAL FINISHING

ORGANIC FINISHING GROUP

THE first meeting of the Group will be held at the Rembrandt Hotel, South Kensington, London, S.W.7 on September 22. It will consist of a joint meeting with the Industrial Finishing Luncheon Club. The afternoon session will be devoted to a paper presented by Mr. F. C. Faulkner, entitled "Technical Service Problems." All members of the I.M.F. who wish to attend are asked to notify the secretary of the Group, Mr. W. E. Cattley, at 89, Avondale Road, South Croydon, Telephone CROydon 8740. Mr. Cattley's business telephone number is CROydon 2791.

S.C.I. CORROSION GROUP SYMPOSIUM

A SYMPOSIUM on the Protection of Cable-Sheathing against Corrosion is being arranged by the Corrosion Group of the Society of Chemical Industry to take place on Friday, November 18th, 1955 at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. Five papers will be presented and discussed as follows:—

1. "The 'Phenol Corrosion' of Lead" by R. L. Davies and E. L. Coles (British Insulated Callender's Cables Ltd.).
2. "Cathodic Protection Telecommunications Cables" by J. Gerrard and J. R. Walters (Post Office).
3. "The Protection of Buried Power Cables" by J. H. Gosden (Central Electricity Authority).
4. "The Behaviour of Aluminium-Sheathed Cables" by P. A. Raine (Johnson & Phillips Ltd.).
5. "The Mechanism of Corrosion of Metal Pipes in Soils and Practical Methods of Prevention" by W. W. Robson and A. R. Taylor (Associated Lead Manufacturers Ltd.).

Further details and forms of registration may be obtained from the Society of Chemical Industry, 56, Victoria Street, London, S.W.1.

PRICES OF BORON PRODUCTS

BORAX CONSOLIDATED LTD., and Borax and Chemicals Ltd., announce price increases, effective from October 1, for their products. The increases which range from £1 to £1 10s. per ton depending on the product, are due to increasing costs, particularly wages.

British Brush Manufacturers Research Association

A LICENCE recently granted by the Board of Trade allows the Association to drop the word "Limited" from its name. The Association remains a company, limited by guarantee and its organization is unaffected.

INDUSTRIAL ACCIDENT PREVENTION CONFERENCE

THE Minister of Labour, Sir Walter Monckton, and three leading industrialists will speak at Guildhall on Friday, October, 28 on the urgent necessity to reduce the number of accidents occurring in British industry.

The occasion is a one-day Conference to be opened by the Lord Mayor of London.

Sir Ewart Smith, deputy chairman of Imperial Chemical Industries Ltd., and chairman of the British Productivity Council, will speak on "Accident Prevention and Productivity"; Mr. A. E. Amor, deputy managing director of Kodak Ltd., on "Accident Prevention and Man-power"; and Mr. P. E. Trench, managing director of Bovis Ltd., on "Accident Prevention and Efficiency, with Particular Reference to the Building Industry." At the close of the Conference the papers will be summed up by Mr. H. R. Payne, chairman of the National Executive Committee of the Royal Society for the Prevention of Accidents.

The Conference is being organized by the London Industrial Co-ordinating Committee which represents five industrial accident prevention groups who work in and around London. The Industrial Safety Division of the Royal Society for the Prevention of Accidents is also closely associated with the Conference. The Conference is the principal event of National Industrial Safety Week.

The object of the campaign is to encourage all workers, but particularly young workers, to "start a safety habit today," and to remember that "safety habits last a lifetime." During the launching week it is hoped to introduce these two slogans into every factory, large or small, throughout the United Kingdom. The campaign also sets out to bring into the voluntary safety movement a great number of the smaller industrial concerns which at present have little or no safety organisation in their factories.

The Conference is open to anyone interested in industrial accident prevention. Admission is by tickets only. These may be obtained from the Hon. Treasurer, Mr. H. Meanley, North Thames Gas Board, Kings Road, Fulham, London, S.W.6. at 10/6 each.

Latest Developments in PLANT, PROCESSES and EQUIPMENT

Plating by Cluster Barrel

IN the course of manufacture of small metal component parts such as rivets, screws, etc., the plating industry and engineering works in general have often felt the need of some form of fully immersed plating barrel suitable for a variety of processes in which small batches of different types of articles can be plated at the same time.

The recent development of the Efco-Udylite Perspex cluster barrel affords a solution to this problem which will be widely welcomed.

A cluster barrel—as the new device is termed—consists of twelve containers fitted on to a central shaft by means of suitably insulated spring clamps (see Fig. 1). The main shaft and spring clamp carry the current to the containers by cable to two horns on the main structure. Since the structure is identical with the standard barrel equipment supplied by Efco it will fit into the normal plating sequence, and is suitable for all types of cleaning processes and plating solutions except for bright zinc and chromium.

The cluster barrels are made in Perspex with stainless-steel cathode contact plates and bayonet-type lugs. All lids are interchangeable with each other and the barrel assemblies themselves are interchangeable, so that additional containers can be used to avoid delay during loading and unloading.

The Perspex construction is unique in that the barrels can be taken through hot alkali cleaner, water rinse, acid dip and acid or alkali plating processes without any intermediate transfer of work being necessary, with a consequent material decrease in handling costs.

The external dimensions of the containers are 5 in. in diameter and 7⅜ in. long and each will hold approximately 4½ lb. of 2 BA nuts.

The current drawn on various solutions varies according to conditions; as an example, in a recent test with 50 lb. in 10 barrels the current drawn was 380-410 amp. at 15 volts for bright nickel. An idler pinion between the existing drive pinion and the Perspex ring gear enables the barrel at all times to be fully immersed in the plating solution.

This versatile unit, which is obtainable from Electro Chemical Engineering Co. Ltd., Queens Road, Weybridge, Surrey, is likely to have wide application in the metal component finishing industries.

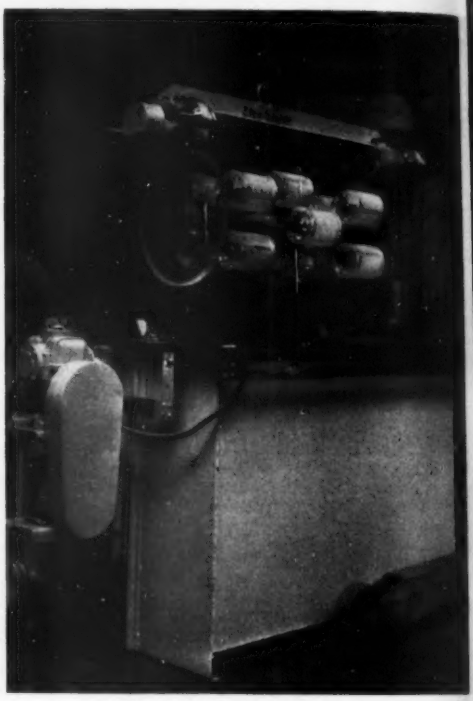


Fig. 1.—Cluster plating barrel.

Chemical Removal of Mill Scale

THERE is even today a widely held, but completely erroneous, belief that an inherent layer of mill scale on steel offers reasonable protection against corrosion to the underlying metal and forms a suitable base for paint. It is however, slowly being recognized that this is far from being the case and that the breakdown of a number of paint systems has been brought about by a failure to remove the scale layer completely and effectively.

A number of processes are currently being used for the removal of mill scale, including the antiquated and inefficient method of weathering. Pickling and shot blasting are also used as well as the efficient, modern process of flame de-scaling. The disadvantages of these are, in the case of structural steel work in particular, that most of the members involved are of awkward size and shape for shop processing and the treatments often do not lend themselves to application on site.

Interest will therefore be shown in a new range of de-scaling products announced by Jenolite Ltd., 13-17, Rathbone Street, London, W.1. These de-scalers are in jelly form and are applied to the steel surfaces on site where they adhere for sufficient time to remove all traces of scale.

These products are manufactured in two broad classifications, the first of which is applied by brushing

or swabbing and left on the surface for about eight hours. No rinsing or neutralizing is needed after treatment, the excess product merely being removed by scraping and wiping. The application of a suitable rust-removal and phosphating treatment to ensure adequate paint bonding is recommended to follow the scale removal.

The other type is designed for removal of particularly heavy scale and should be left on the surface for some twenty-four hours. When de-scaling is complete the steel surface requires washing down and when dry is ready for a suitable protective treatment.

Paint Heater

A NUMBER of advantages are claimed for an improved paint heater recently put on the market by T. C. Spray Finishing Systems, 5, St. James' Place, S.W.1., called the Econ-o-matic, the new heater (Fig. 2) is light in weight, compact in design and requires the minimum of maintenance. Heat-up is rapid, working temperature being reached in 3 to 4 minutes.

As shown in Fig. 2b the heater body can be disassembled by the removal of eight bolts, exposing the whole of the paint passages for cleaning when necessary. By the removal of four more bolts all the electrical assembly is made accessible for service or replacement.

This equipment is available in straight-through and circulating types with ratings of 1,250 and 2,500 watts, and can be used not only for hot spraying but also, by virtue of its small size, it can be fitted to either pressure containers or paint circulating lines for control of paint temperature. Temperature can be maintained as low as 100°F. thus ensuring standard viscosity and assisting the production of a uniform finish.

Barrel Finishing Compounds

LACRINOID Products Ltd., Gidea Park, Essex, specialists in the production of compounds for barrel finishing, have announced that they have developed a series of compounds superseding those which they have marketed hitherto, which they claim to be suitable for all types of surface-finishing operations on all metals with the object of obtaining finishes satisfactory for subsequent electroplating.

These compounds are designed for use in conjunction with "Lacron" fused aluminium-oxide chips. The products, which are variously liquids and powders, are five in number and have been developed for specific purposes covering all barrel-finishing operations. They comprise a highly concentrated liquid detergent for degreasing and cleaning of all metals; a mildly abrasive compound in powder form which in conjunction with the appropriate grade of chips provides rapid de-burring and fine surfacing of all metals; a bright burnishing and colouring powder-compound suitable for all metals, which produces a very high lustre. Also available is a strongly acid liquid for the rapid de-scaling of all iron, steel and steel alloy parts, and an alkaline powder which acts as a cleaner, brightener and rust inhibitor for iron, steel and steel alloys.

Details of these products are given in a brochure published by the company which is available on request.

Pneumatic Transport of Dust

THE pneumatic transport of solids usually entails high capital and running costs, even with a well-designed system. These costs can be excessive in dust extraction and collection installations where the volume of contaminated air that has to be entrained into a plenum system to ensure satisfactory ventilation far exceeds the volume of air required for the pneumatic transport of the particulate matter suspended in the entrained air.

However, in dust-extraction systems designed by Dallow Lambert and Co. Ltd., Leicester, where the collected dust has to be conveyed an appreciable distance to the final disposal point, this tendency has been mitigated to some extent by siting the dust separator as near as possible to the area of extraction and employing an independent pneumatic transport system to carry the dust to the disposal point. The collected dust is fed into the secondary system by means of a venturi throat. Only the minimum amount of air necessary to prevent dust settling in the ducts is used and this is much less than the volume of air

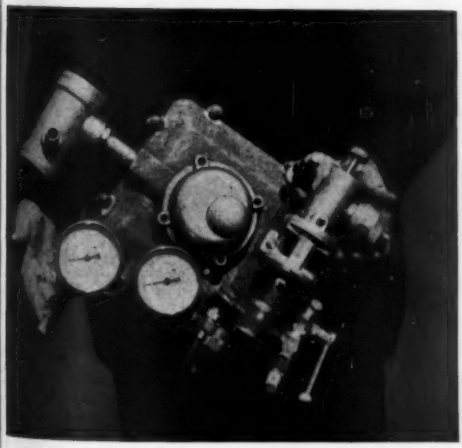


Fig. 2 (left).—Paint heater.

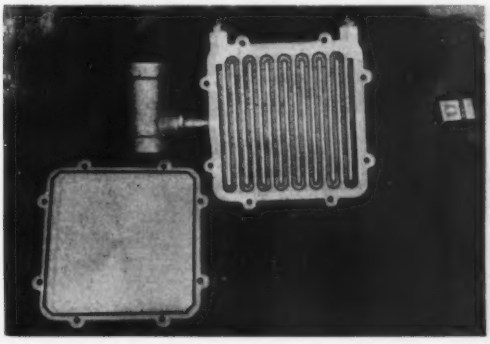


Fig. 2b (below).—Paint heater body dismantled.

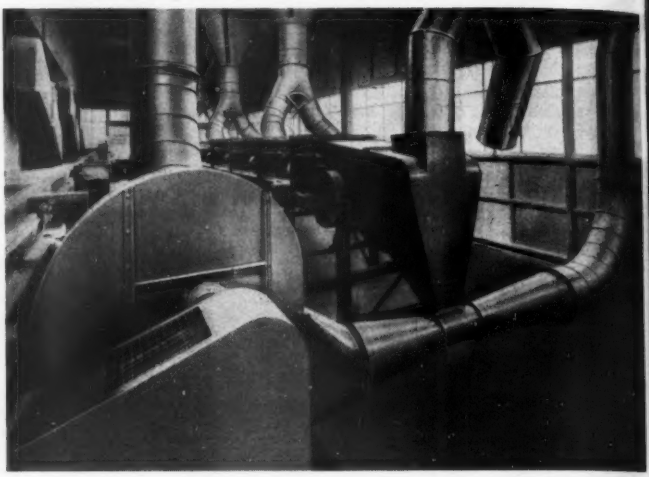


Fig. 3.—Dust extraction system.

originally entrained, resulting in savings in power and capital costs. Furthermore this air can be drawn from outside the building and is therefore clean, thus avoiding wear and abrasion on the fan impellor.

Fig. 3 shows collected dust being conveyed from cyclone cone exits to the pneumatic transport system *via* the venturi.

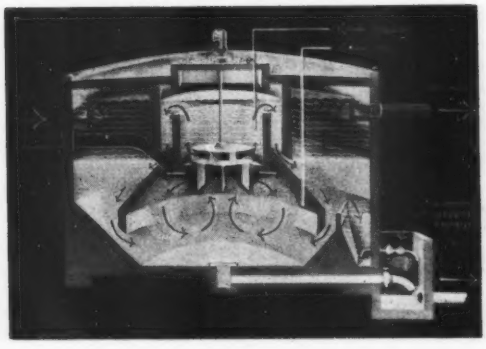
Water Treatment Plant

THE treatment of hard or otherwise contaminated water prior to its use in a workshop process or its discharge to a sewer often involves a number of chemical engineering problems, particularly when the use of a thick slurry is called for.

The Accelator plant manufactured by the Paterson Engineering Co. Ltd. of London and shown diagrammatically in Fig. 4 incorporates the novel idea of actually allowing precipitation to occur in the presence of comparatively fresh pre-formed slurry and means are provided for circulating this fresh slurry with the water being treated. Furthermore, provision is made for maintaining this sludge bed in a mobile condition and in such a manner that it actually squeezes the softened water from the bed, thus giving a relatively clear softened water in the upper part of the plant.

In general the plant consists of a vertical and relatively large-diameter main outer steel-plate cylinder containing an inner reaction portion formed also of steel plate. The raw water enters by an inlet-pipe at the side of the main cylinder and passes to what is known as the agitator hood, a wide diameter circular closed chamber in the lower part of the main cylinder with a top hood or cover. The upper portion or extension of this hood is a vertical jacketed cylinder, of less diameter reaching almost to the top of the main cylinder, and is known as the secondary main mixing zone, down the centre of which is a vertical shaft driven by a small electric motor at the top of the reduction gear, constituting a vertical paddle shaft. This latter extends to the bottom of the agitator hood chamber or primary mixing zone and is provided with agitators of the rotor type which give a violent agitation.

Fig. 4.—Water treatment plant.

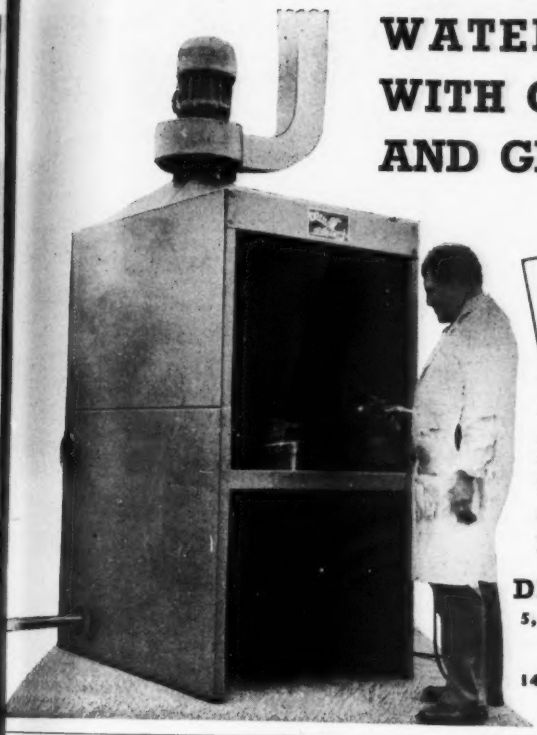


The chemical reagents (lime and soda ash) enter by a pipe into the top portion of the agitator hood and the action of the agitator gives instantaneous and intimate mixing of the raw water with the reagents and also the slurry, which is forced up into the upper secondary mixing zone by the action of the rotor agitators immediately below. Also at the top of the secondary mixing zone coagulent solution (aluminium sulphate or sodium aluminate) is added continuously where a more or less gentle agitation is given by the simple agitators already mentioned, operating in conjunction with the baffles.

Normally the lime and soda solutions are added in the form of a magma but if required they can be added separately so that in the case of a variable water the dose of either lime or soda can be altered independently. The speed at which the process is carried out by the Accelator is shown by the fact that when samples are taken from the top of the centre tube it will be found that the reaction is almost complete. A sample of circulating slurry from the centre tube when allowed to settle in a cylinder starts to clear in a matter of seconds and within five minutes the supernatant liquor is brilliantly clear.

Spray-Painting Plant

THE PR.303E spray painting plant (Fig. 5) manufactured by Alfred Bullows and Sons Ltd., Long Street, Walsall, Staffs., has now been available for 3 years and at the present time there are some 5,000 giving very satisfactory service in the domestic market.



WATER WASH BOOTHS WITH CLEANER EXHAUST AND GREATER SIMPLICITY

For all Paints and Vitreous Enamels

It is possible to get a much more complete recovery of over-spray frit, in much better condition for re-use, in much less time than is usually the case in this trade. The difference in all these respects from existing methods is a pleasant revelation.

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Latest Developments in Plant, Processes and Equipment

In accordance with the company's policy of continuous development, certain alterations and improvements have been made to the plant in its original form.

There have been some failures of the bonded rubber coupling, and this has now been replaced by a claw-type coupling, which it is impossible to break or wear out.

The lubrication system is operated by air pressure, and a few cases have occurred where plants have been connected up in such a way that they have operated at a lower pressure than the minimum for safe lubrication. A minimum-pressure valve has been designed, and is now fitted as standard to all machines. The effect of this is to make it impossible for even the most careless operator to damage the machine, because, even with the discharge wide open, this valve ensures a safe minimum working pressure.

The machine incorporates a Hydrovane compressor which is absolutely silent in operation, and all moving parts are submerged in an oil bath, so that wear is virtually eliminated. The compressor with its 1/3-h.p. motor weighs 42 lb. and is easily carried in one hand. The L.800 internal atomization gun and hose complete the plant.

Fig. 5.—Spray-painting equipment.

Classified Advertisements

Prepaid rates: TWENTY WORDS for 5s. (minimum charge) and 2d. per word thereafter, or 12s. per inch. Box number 2s., including postage of replies.

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

SITUATION VACANT

CHIEF CHEMIST

Applications are invited for the position of **CHIEF CHEMIST** and **METALLURGIST** with Briggs Motor Bodies Ltd. This appointment is for a man to take complete charge of the laboratories controlling qualities of raw materials used in the manufacturing groups, and include the analytical, metallographical and X-Ray, physical testing and technical control of processes used. Knowledge of steel press work, welding and chemical processes used in connection with paint finishes, electro-plating and manipulative processes of materials such as textiles, plastics and rubber is required. This is an appointment to the senior staff of the company requiring an appropriate University degree or the equivalent, and carries a salary commensurate with the responsibility involved. Applications from men with the experience and qualifications required should be made to Mr. D. L. WARD, Chief Engineer, BRIGGS MOTOR BODIES LTD., Dagenham, Essex.

SITUATIONS VACANT

VITREOUS ENAMEL/GLASS and **REFRACTORY TECHNOLOGISTS** are required for Research and Development Work on Vitreous Enamels and General Ceramics at Laboratories situated in Warrington. Whilst University Graduates are preferred, candidates having industrial experience in one of the Ceramic fields are invited to apply for these vacancies. Replies should be addressed to: RADIATION CERAMICS RESEARCH DEPARTMENT, RICHMONDS GAS STOVE COMPANY LTD., Grappenhall Works, Warrington.

SURFACE TREATMENTS. Important organization requires Manager with first-class administrative experience. Salary commensurate with qualifications. Write full details in confidence to Box No. 511, METAL FINISHING JOURNAL.

FOR SALE

COMPLETE ROTAMATIC PLATING PLANT BY CANNING. Bath 10′ × 4′ × 3′, internally and externally rubber-lined throughout. With heating coil, busbar, motor, reduction gear, conveyor, hangers, etc. All in sound condition. Just removed from service to make room for a larger plant. Offers for quick sale to CLARKE, ANDRE RUBBER CO., LTD., Surbiton, Surrey. (Elmbridge 6580.)

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